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MOBILE CONTENT REVENUE ASSURANCE

Master's Thesis submitted in partial fulfillment of the requirements for the degree of Master of Science in Technology.

Espoo, May 26, 2009

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ABSTRACT OF THE MASTER'S THESIS

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Mobile content is a steadily growing business, which is expected to keep growing at a fair rate according to the reports published by the Ministry of Transport and Communications of Finland. At the same time revenue assurance as a corporate level function for mobile operators has received a lot of attention in the recent years. Coupled with the growing market and new billing models emerging for mobile content, the idea for prioritizing the revenue leakage risk areas of mobile content was chosen as the basis for the study. The mobile content business also includes revenue sharing to the service provider, which further differentiates it from the traditional voice revenue chain.

The study roughly follows the eight step case study process by Eisenhardt [Eis89]. The appropriate scope for the study was defined by revenue assurance disciplines, domains and levels. Data gathering methods included opportunity maps and expert interviews to offer another angle. Survey results of the most common revenue leakage causes for operators were used to help analyze the results. Comparisons between the mobile content and voice revenue chains by functions were used to estimate the generalizability of the results.

The study answers the research question by prioritizing revenue leakage risk areas into primary and secondary areas. The primary areas are systems, which filter and modify data records. The secondary areas are rating systems, data record generating platforms and the IN for operators with a high prepaid subscriber base.

The mobile operator should use the results of the study as a starting point for directing revenue assurance activities for mobile content. Beyond the high level analysis performed in this study, there are areas which require further research and may alter the prioritization. Data record creating platforms and other mobile network elements were identified as such areas. After identifying and securing current revenue leakage areas, proactive approaches for preventing leakage should also be researched.

Keywords: Revenue assurance, revenue leakage, mobile content, mobile operator, service provider, prioritization

TEKNILLINEN KORKEAKOULU DIPLOMITYÖN TIIVISTELMÄ

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Mobiilisisältöpalvelut ovat jatkaneet tasaista kasvuaan viime vuosien aikana ja Liikenne- ja viestintäministeriön julkaiseminen tietojen mukaan kasvun odotetaan jatkuvan lähivuosina. Liikevaihdon varmistaminen on ollut myös ollut huomion kohteena mobiilioperaattoreilla viime vuosina. Mobiilisisällön liikevaihdon vuotojen riskialueiden priorisointi valittiin tutkimuksen perustaksi markkinatilanteen sekä mahdollisten uusien laskutusmallien mukaantulo huomioiden. Mobiilisisältöliiketoiminta sisältää myös tuloutuksen palveluntarjoajalle, joka toimii toisena erona verrattuna perinteisempään puheliikenteen liikevaihtoketjuun.

Tutkimus seuraa karkeasti Eisenhardtin [Eis89] kahdeksanportaista tapaustutkimusprosessia. Työn laajuus määriteltiin liikevaihdon varmistamiseen liittyvillä opinaloilla, alueilla ja tasoilla. Tiedonkeräysmenetelmiin kuuluivat tilaisuuskartat sekä asiantuntijahaastattelut. Kyselytuloksia yleisimpien liikevaihdon vuotojen syistä käytettiin apuna tulosten analyysissa. Vertailuja mobiilisisältö- ja puheliikevaihtoketjujen välillä suoritettiin tulosten yleistettävyyden arvioimiseksi.

Tutkimuskysymykseen vastataan priorisoimalla liikevaihdon vuotojen riskialueet ensisijaisiin ja toissijaisiin alueisiin. Ensisijaiset alueet ovat järjestelmiä, jotka suodattavat ja muokkaavat tikettejä. Toissijaisia alueita ovat hinnoittelujärjestelmät, tikettejä luovat alustat ja IN operaattoreille, joilla on paljon prepaid liittymäasiakkaita.

Mobiilioperaattorin suositellaan käyttävän työn tuloksena määritettyä priorisointia liikevaihdon varmistamiseen liittyvien toimien kohdistamiseen mobiilisisällön liikevaihtoketjussa. Työssä esitetyn korkean tason analyysin lisäksi esille tuli alueita, jotka vaativat lisätutkimusta ja saattavat muuttaa priorisointia. Tikettejä luovat alustat ja muut mobiiliverkon elementit tunnistettiin tällaisiksi alueiksi. Kun liikevaihdon vuotoalueet on tunnistettu ja varmistettu, ennaltaehkäiseviä lähestymistapoja vuotojen estoon tulisi myös tutkia syvemmin.

Avainsanat: Liikevaihdon varmistaminen, liikevaihdon vuoto, mobiilisisältöpalvelut, mobiilioperaattori, palveluntarjoaja, priorisaatio

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The results of the work are largely dependent on the help of many other people from TeliaSonera as well. I want to thank all the interviewees for sharing their time and knowledge.

There are also external factors, which have contributed to the success of the study. Aside from the most obvious incentive, I want to thank my friends and family for support and for making the time outside my studies and work an interesting experience.

There is one person, who deserves special thanks. I look forward to returning the favor for all the support during the years I have spent studying.

Espoo, May 26, 2009

Lasse Rautopuro

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Abbreviations

Generic Terms

RA Revenue Assurance

TSF TeliaSonera Finland, also used in place of Sonera brand products

3G handset 3G enabled cellular phone, may also be referred to as a mobile handset or a mobile terminal depending on context

IMSI International Mobile Subscriber Identity

SP Service Provider

CP Content Provider

DCH Data Clearing House - a broker for billing events (roaming in the context of this work)

SOX Sarbanes-Oxley Act

Technical Terms

SMSC Mobile network component: Short Message Service Center

MMSC Mobile network component: Multimedia Messaging Service Center

SGW Mobile network component: Signaling Gateway

SGSN Mobile network component: Serving GPRS Support Node

IN Intelligent Network

CSD Circuit Switched Data

GPRS General Packet Radio Service

Outbound Roaming Local (TSF) operator's subscribers' roaming events in foreign networks

Inbound Roaming Foreign operator's subscribers' roaming events in local (TSF) network

IOT Inter Operator Tariff

CDR Call Detail Record - A Call Detail Record, also known as Station Message Detail Record (SMDR), is a record containing information relating to a single call or session. The format of CDRs is not fixed and therefore varies between networks. CDRs are generated by network elements in the serving network and they are sent to the billing system in the home network.

EDR Event Data Record - Similar to CDR, but generated for other types of events such as mobile content transactions.

Data record A generic data record containing billing and other information, like a CDR or an EDR

Chapter 1

Introduction

1.1 Background and Motivation

In 2003 to 2005 the competition between Finnish mobile operators focused mainly on the pricing of voice calls and short messages (SMS). The churn of mobile subscriptions was also relatively high (1,5M subscriptions were transferred between operators in 2005 out of 5,4M[1] subscriptions total). The operators could not differentiate their services much partly because of the outdated mobile handset base in Finland. Many subscribers have been satisfied with basic voice call and SMS services and not all phones sold in 2005 even had WAP functionality or a colour display. Also, some subscribers did not bother to set up the operator's data service settings if they did not work right away further reducing the available customer base for mobile content [Min06].

In April 2006 subscription and 3G mobile handset bundling became legal for operators in a three year study by the Ministry of Transport and Communications of Finland. Low to mid-priced 3G mobile handsets have also recently become more available and operators are now finally able to offer preinstalled service capable phones bundled with a subscription at reasonable prices.

Because of bundling the barrier for using mobile content is significantly lower than before and it will signal growing markets and new types of billing opportunities. The size of the Finnish mobile content market was 77 million in 2006 and it is expected to grow to over 90 million by the end of 2009. In 2006 the number of 3G handsets grew from 45000 units to 530000 units. Although the first year of subscription and mobile handset bundling may be viewed as an anomaly in mobile handset sales, the growth is expected to continue at a fair rate [Min07].

Various mobile content services are already available to consumers and there are different billing processes involved based on the type of service and delivery. The de-

[1] The number of actual users is lower, because some users own more than one subscription.

livery process may involve sending a short message to a service number and receiving a short message in reply like a mobile public transport ticket in Helsinki. Another example of mobile content is a downloadable mobile game where a data connection has to be established to receive the ordered item. Other types of mobile content include ring tones, music, chat and dating, search engines, mobile TV and similar services. The mobile operator falls in the middle of the delivery and billing process and some errors are inevitable due to the multitude of interfaces and delivery steps involved.

The motivation to explore the mobile content billing network comes from the fact that revenue leakage already happens in other mobile operator billing systems. In consumer voice billing revenue is lost due to errors in source systems and call detail records, for example, and the estimated loss can be anywhere from 2 to 15 percent of billable revenue [Mat05, Tel06]. Customer service reclamations from TeliaSonera Finland also indicate, that a part of the billing errors are mobile content related.

There are also other considerations, which differentiate mobile content as a business from the traditional domain of revenue assurance, voice services and more recently mobile messaging. Voice and messaging as services are rather straightforward transactions, involving only subscribers and the operator. While sheer volumes of traffic, network and billing infrastructure, prepaid and postpaid billing considerations and roaming are certainly not minor problems in terms of revenue assurance, the scenario gets somewhat more complex with the addition of third parties who provide the content.

Mattison writes about the problem generally related to 3G services and revenue assurance [Mat07a]:

> Most telcos do not have the ability to deliver the content services (weather, news, sport, gaming, etc.) that are the backbone of most 3G offerings. Because of this, the telco must develop business models and partnerships with vendors that clearly define:
>
> - The roles of the content providers and carrier
> - How the services will be delivered to end users over the network
> - How the volume and nature of the delivered services will be tracked and reported
> - How the services will be billed (by whom and at what rate)
> - Who will be responsible for collections and credit risk
> - And a myriad of other issues

Finally, revenue assurance has recently been the the center of attention not only due to the falling economic state of the world, but also [Mat05]:

- The new wave of regulatory interest in how telcos monitor and report on their revenues (i.e. Sarbanes-Oxley)
- Increasing pressure to show more profit and reduced operating budgets, making it critical for management to exploit all areas of potential revenue realization
- The struggle of existing revenue management systems to keep up with the continuing breakneck pace of technological and marketing innovation

As the mobile content market is starting to expand operators will need to know where the risk factors in mobile content billing lie and how to prioritize relevant revenue assurance activities. Exploring revenue leakage risk areas around mobile content will help better define the overall picture of revenue assurance functions within the operator's business.

1.2 Objective

1.2.1 Defining the Objective

Getting started with the topic of the study loosely follows the eight stage research process defined by Jenkins [Jen85, JJ04]:

1. Idea
2. Library Research
3. Research Topic
4. Research Strategy
5. Experimental Design
6. Data Capture
7. Data Analysis
8. Publish Results

The first three steps and their relation to the study are explained in this section, while the rest are covered in Section 1.5 and Section 1.6.

First there was the idea of exploring revenue assurance functions at a mobile operator, which was further refined into focusing on mobile content and a single operator in order to make the scope manageable.

The library research has been an ongoing process throughout the study due to two reasons: the scope of the work has been cut as more information has become available

and there have not been many published information and books on revenue assurance until only at the later stages of this work.

In order to define the research objective, it is helpful to break down the third step of the research process into three items [JJ04]:

1. The initial research question - what do we want to find out?
2. Research motivation - why do we want to know it?
3. Defining questions - which specific questions need to be answered in order to answer the initial research question?

The Initial Research Question

If we look at a mobile operator's business, it is easy to get lost in all the network, mediation and billing systems. Which of the systems are important for mobile content and for the evaluation of revenue assurance issues?

By first defining the specific discipline, domains and levels of revenue assurance, which the study is going to address, the relevant systems at the mobile operator will be easier to identify. The Global Revenue Assurance Professionals Association (GRAPA) has defined four disciplines of revenue assurance [Glo09]:

1. Forensic Analysis - The assessment of risk, root cause analysis and the determination of the appropriate level or correction for a given area
2. Controls Management - The design, implementation, execution and monitoring of controls
3. Corrections - Assuring that recommended changes to operational methods and systems are implemented in response to identified risks
4. Compliance Management - Making sure that forensic investigations, corrections and controls are being executed and managed as specified

The first discipline, forensic analysis, comprises of preliminary assessment activities and it should provide answers to the following issues:

- How the area functions
- What the major revenue risk and loss vulnerabilities are
- What the different ways the containment or repair of the risk might be

Since there is no revenue assurance function directly associated with mobile content at the time of writing, the study will focus on this first discipline in order to generate a prestudy of the subject for further activities.

After conducting the analysis, two results should be made available [Glo09]:

- The size and extent of revenue risk or loss (in measurable and reportable terms)
- A recommendation regarding how the areas should be covered in the future

And recommendations for follow-up can include:

- The scheduling of another assessment at a future date
- The creation of a set of operational controls (controls management)
- A serious reengineering of aspects of the operation (correction)

This assessment defines the discipline of revenue assurance, that will be the focus of the study. The full scope of the forensic analysis discipline is not covered, but the study should produce advice on where to focus revenue assurance activities in the mobile content revenue chain. The revenue assurance domains, levels and their relation to the actual operational systems of the operator will be explained in Section 1.4, where the scope is defined.

Research Motivation

The motivation is based on the fact, that there is no overarching revenue assurance function for mobile content at the operator being studied and that the systematic application of revenue assurance is a relatively new field. Mobile content itself is an emerging business, that comprises of many different billing models while also adding third party content providers to the traditional operator - subscriber relationship [Mat05, Mat07a]. TSF offers interface products to service providers, through which service providers can deliver their content to subscribers and have it billed. This puts the whole mobile content value chain in a unique position when compared to mobile voice and messaging, since it contains both service providers and subscribers.

Defining Questions

These focused questions follow from the selection of the revenue assurance discipline, domains and levels and are presented along with the main research question in Section 1.3.

Research Objective

Based on the issues addressed by the forensic analysis revenue assurance discipline and supporting background information, the main objective of this study was chosen to be:

> **Main research objective:**
> *Discovering and prioritizing revenue leakage risk areas of mobile content services from the mobile operator's perspective*

1.2.2 Criteria of Success

The study may be considered successful under the following criteria [Yin94]:

- Main research question answered based on a chain of evidence from the initial research phase to the analysis of results
- Multiple sources of evidence used in defining the risk area priority

1.2.3 Deliverables

The study will result in the following deliverables:

- Master's Thesis document as the case study report
- Summary of the interviews conducted for data collection
- Case study database for internal use

1.3 Research Question

Based on the background information presented in Section 1.1 and Section 1.2, the main research question can be stated as follows:

> How should a mobile operator prioritize their revenue assurance activities related to mobile content?

In order to answer the main research question, the following focused questions will be answered in the course of the study:

- What is revenue assurance?
  - What are the origins of revenue assurance in telecommunications?

  - How is revenue assurance practiced today and which issues does it address?
  - What are the different disciplines, domains and levels of revenue assurance and which of them should be included in the scope of the study?

- What is mobile content?
  - What kind of mobile content is available for consumers?
  - What kind of options are available to content and service providers?
  - Which mobile content will be in the scope of the study?
  - How is mobile content ordered?
  - How is mobile content billed and how does revenue sharing work?

- How does the revenue chain of mobile content compare to voice and messaging?
  - Which parts of the delivery and billing network are shared?
  - What are the similarities and differences in other parts of the chains?

- What are the revenue leakage risk areas of the mobile content revenue chain at TSF?
  - How should the risk areas be defined?
  - How should the risk areas be prioritized?
  - What is the priority of the risk areas?

- What conclusions and suggestions can be made on the revenue assurance approach to mobile content?

1.4 Scope

1.4.1 Required Information

Defining the scope of the study requires a clear identification of which systems, operations and functions of the mobile operator will be addressed. After this assessment the objective for the revenue assurance activities of the chosen domain can be set [Glo09].

The revenue assurance discipline chosen for this study deals with preliminary assessment activities. GRAPA has also defined domains and levels of revenue assurance, which are the focus of this section and will help define the scope of the work.

1.4.2 Revenue Assurance Domains

Definition of Revenue Assurance Domains

GRAPA has defined the revenue assurance domains as follows [Glo09]:

> A domain is the term utilized to define that collection of systems, operations and functions are included within the scope of the RA activity. Each domain brings with it a unique:
>
> - Operational Environment
> - Vocabulary and terminology
> - Operational principles
> - Business objectives
> - Revenue assurance issues and approaches
> - Revenue risks
> - Industry standard controls

Vertical Domains

According to GRAPA, the inventory of vertical domains includes systems, BSS or OSS (Business or Operations Support Systems) components, operational areas and departments like [Glo09]:

Table 1.1: Examples of vertical revenue assurance domains: Systems, BSS or OSS components, operational areas and departments

Vertical Domains	
Systems, BSS or OSS Components	Operational Areas, Departments
Network elements (switches, gateways, IN, servers, SMSC, MMSC, others)	Collections
Mediation Systems	Credit Management
Postpaid Billing Systems	Fraud Management
Interconnect Billing Systems	Sales Management
Roaming Billing Systems	
CRM Systems	
Customer Management Systems	
Point of Sale Systems	
Provisioning Systems	
Sales Channel Management	

Vertical domains deal with assurance of one particular operational area within a larger revenue management chain. A vertical domain is a system, department or operation that processes, captures or manages revenue information for a single or a number of different revenue streams [Glo09]. Network elements and mediation, for example, serve many kinds of products lines without regard for customer segments, both of which are often kept separated when reviewing revenue.

Horizontal Domains

Horizontal domains of revenue assurance encompass all the systems within one revenue stream. Typically, all transactions for the same product or line of business traverse the same revenue chain and represent a horizontal domain.

Horizontal domains include [Glo09]:

Table 1.2: Examples of horizontal revenue assurance domains

Horizontal Domains
Product Lines (Voice, Data, SMS, MMS, TV, Streaming, IP)
Specific Products / Rate Plans
Customer Segments or Markets (Consumer, Business)

1.4.3 Revenue Assurance Levels

After identifying the domain in which the revenue assurance activies are to be performed, the next step is defining an objective for the activities. GRAPA has classified these objectives as revenue assurance levels and they include [Glo09]:

Leakage Containment: Assuring against leakage and containment requires revenue assurance practitioners to seek out situations or systems where revenue that has been earned is not being accurately processed. The job of revenue assurance in these cases is to find, diagnose and correct the leakages in an efficient and rationalized manner.

Revenue Risk Containment: At a more mature level, revenue assurance can be a proactive approach which anticipates potential leakage situations and functions to eliminate the risks before a leakage occurs.

Margin and Rate Plan Assurance: Another area where revenue loss may occur is in the area of pricing for different products and services. The creation of bundles and other offers create exceedingly complex revenue tracking scenarios that

can ultimately cost the company money because of the lack of a comprehensive revenue protection based analysis of the assumptions behind its development. The assurance of revenue recognition and accounting for revenues properly is a specialized and critical aspect of some revenue assurance domains.

Revenue Stream Assurance: By aiming for proactive revenue assurance, the objective for a domain can be defined to include not only the revenues earned, but also the revenues of an expected revenue stream. There are several ways that revenue stream assurance is being included:

Network Asset Downtime and Revenue Loss: When major network components (like an MSC) suffer a number of outages, there can be significant and catastrophic revenue impacts. In the past management tended to relegate these issues to the "network issues" category, but most are discovering that they need to keep track of, account for and manage these exposures to the revenue stream in the same manner as the rest of the exposures.

Churn and Brand Equity Erosion: Customer churn and the cannibalization of brand equity represents a major erosion to the revenue stream as well, according to some CFOs. These groups also include churn as a valid revenue assurance issue.

Fraud Management: It has long been understood that there is a large amount of overlap between the domain, tools and scope of the fraud management function and the revenue assurance function. GRAPA benchmarks show that the vast majority of telcos have been known to include fraud as a integral component of the overall revenue assurance mission.

1.4.4 Scope Summary

Included in the Scope

Based on the definitions of revenue assurance disciplines, domains and levels the scope of the study can now be fully defined. With a lot of confusion about the general scope of issues revenue assurance addresses [Tel06, Mat05], this section is split into two parts which describe what will be included in the scope of the study and what will specifically be left out.

The current mobile content delivery and billing network using either messaging or WAP technology at TeliaSonera Finland will be examined. The focus is on parts of the delivery and billing network the mobile operator can affect. This covers internal billing systems and interfaces involved both towards the mobile network and the service providers.

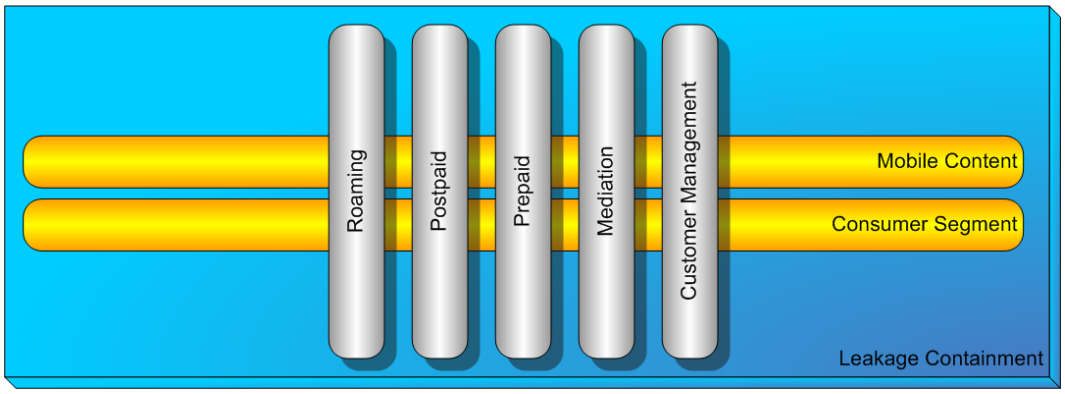

Figure 1.1: Selected revenue assurance domains and levels.

Figure 1.1 shows the relevant domains and levels for the study. Mobile content and the consumer segment are the relevant horizontal domains. Other horizontal domains, such as voice, SMS and MMS share parts of the billing network and are used for comparison purposes. Since they are not the main focus of the study, they are not included in the selected domains. The consumer segment is selected for ease of comparisons, since business subscriptions often have restrictions on ordering mobile content.

The relevant vertical domains are Prepaid, Postpaid, Mediation, Roaming and Customer Management. Since the objective is to find and prioritize revenue assurance risk areas as a prestudy, Leakage Containment is identified as the appropriate level of RA for the study.

Roaming is included in the scope, but since content service providers must manage billing with each operator separately, roaming affects mobile content billing only indirectly when dealing with service providers whose billing is managed by TSF. This means that only subscribers of Sonera and TeleFinland brands have access to the mobile content services through TSF's network and only they can be billed accordingly using TSF's billing systems.

How the chosen level and domains relate to products and systems at TSF is explained in Chapter 3. Since the study deals with only one operator, the results are presented as Case TeliaSonera Finland.

Out of Scope

Customer fraud and bad debt (customer refusing to pay, for example) will not be included in the scope of the study as sources of possible revenue leakage. This will be most visible in the approach on how to find and prioritize the revenue leakage risk areas, as explained in Section 1.5.

While many mobile content services require some form of data transfer to deliver the content (like mobile games), the actual data package billing of subscribers is excluded from the scope. The focus is on how the actual content is billed and not on the data traffic charges, which may be required for delivery of the content.

1.5 Methodology

1.5.1 Research Strategy

After discussions with the supervisor of the study and reviewing research methodology, case study as the research strategy emerged as the best candidate for answering the research question.

The technical definition of case study according to Yin [Yin94]:

1. A case study is an empirical inquiry that
   - investigates a contemporar phenomenon wihtin its real-life context, especially when
   - the boundaries between phenomenon and context are not clearly evident
2. The case study inquiry
   - copes with the technically distinctive situation in which there will be many more variables of interest than data points, and as one result
   - relies on multiple sources of evidence, with data needing to converge in a triangulating fashion, and as another result
   - benefits from the prior development of theoretical propositions to guide data collection and analysis

The unit of analysis in this study is the mobile content value chain of TSF from the perspective of revenue risk containment. Since there is only one unit of analysis, the study is *a holistic single-case design* [Yin94].

Case studies deal with empirical evidence collected to draw conclusions on and to answer the research question. The evidence comes in many forms, such as [Yin94]:

- Documents
- Archival records
- Interviews

- Direct observation
- Participant-observation
- Physical artifacts

From this list documentation and interviews are the primary form of evidence in this study. The methods for gathering and analyzing evidence are explained in more detail in Sections 1.5.2 and 1.5.3.

The specific case study strategy chosen for this work follows the process described by Eisenhardt [Eis89]. The process aims for theory generation from case study evidence and it is:

- Highly iterative and tightly linked to data
- Especially appropriate in new topic areas, while the resultant theory is often novel, testable, and empirically valid

The eight step process described by Eisenhardt works on the following basis:

> Theory-building research is begun as close as possible to the ideal of no theory under consideration and no hypotheses to test.

This is not to say, that any possible outcomes should be disregarded before analyzing the collected data. Some assumptions drive the study and may help the hypothesis generation later on, as will be evident with the definition of the case study protocol in Section 1.5.2. The final analysis of evidence, however, will only tell whether the assumptions made have been correct and whether the constructs have a place in the resulting theory.

The steps and their relation to the structure of the study are described in further detail in Table 1.3 on page 22.

Finally there are four criteria for judging the quality of empirical research designs, of which the first three are relevant to an exploratory (hypothesis-generating or theory-building) study [Yin94]:

Construct Validity: Establishing correct operational measures for the concepts being studied

External Validity: Establishing the domain to which a study's findings can be generalized

Reliability: Demonstrating that the operations of a study, such as the data collection procedures, can be repeated with the same results

Internal Validity: Establishing a causal relationship, whereby certain conditions are shown to lead to other conditions

The requirements for the data collection and data analysis phases posed by these tests are further discussed in Sections 1.5.2 and 1.5.3.

1.5.2 Data Collection

Data Collection Methods

The evidence for a case study may come in many forms, as discussed in Section 1.5.1. The methods for gathering the data may also be qualitative (e.g., words), quantitative (e.g.,numbers), or both [Eis89, Yin94, Pat90]. This section will describe the selected data collection methods in order to meet the quality requirements posed by the validity tests and to answer the research question.

The three principles of data collection according to Yin are [Yin94]:

Use Multiple Sources of Evidence: The use of multiple sources of evidence in case studies allows an investigator to address a broader range of issues. With triangulation the potential problems of *construct validity* can be addressed, because the multiple sources of evidence essentially provide multiple measures of the same phenomenon [Yin94]. The triangulation made possible by multiple data collection methods provides stronger substantiation of constructs and hypotheses [Eis89]. Also, the research strategy is not reliant on either quantitative or qualitative evidence, but may incorporate both [Eis89, Yin94, Pat90].

Create a Case Study Database: The collected data should be organized into a case study database, which consists of two separate collections: the data (evidentiary base) and the report of the investigator [Yin94]. Some notes and documents used in the study cannot be made publicly available due to their nature, but all information relevant to the conclusions will be presented as a part of this case study report.

Maintain a Chain of Evidence: To increase the *reliability* of the information in a case study a chain of evidence must be maintained. The principle is to allow an external observer (reader) to follow the derivation of any evidence from initial research questions to ultimate case study conclusions or in other words to have explicit links between the questions asked, the data collected and the conclusions drawn [Yin94]. The implications this on the structure of the study are explained in Section 1.6.

The sources of evidence in this study and methods used to gather them are:

- Interviews
  - Open-ended interview
  - Semi-structured interview (themed interview, expert interview [Fli02, HH91])
- Documentation
  - Review of technical papers
  - Review of specifications
- Direct observation
  - Gathering data of data record traffic
- Archival records
  - Review of customer service reclamations and feedback

Case Study Protocol

The case study protocol is a set of guidelines for carrying out the case study. It is also a major tactic in increasing the *reliability* of the study [Yin94].

Since this study deals with one case and there is only one researcher, the case study protocol used is restricted and it is focused solely on the problems regarding data collection and analysis. The protocol contains information such as [Yin94]:

- Questions asked of the individual case
- Sources of data (where to get answers to the questions)
- Sample strategies (how to get evidence from the sources)
- Questions asked of specific interviewees

The case study protocol used in the study can be found in Appendix A.

Opportunity Map

This study uses a graphical representation called an opportunity map [Mat05] to direct data collection and provide a strong source of evidence for finding and prioritizing revenue assurance risk areas in the selected domains. Opportunity maps are graphical representations of the revenue assurance domain, which are enhanced with qualitative and quantitative results. The opportunity maps can show:

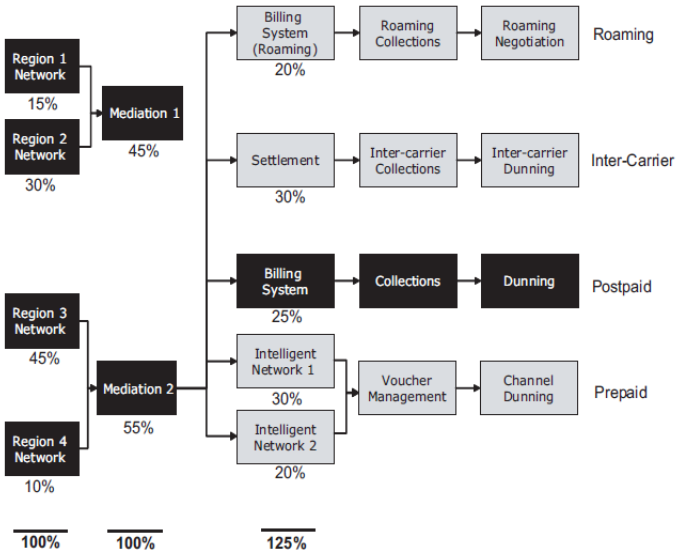

Figure 1.2: Traffic distribution by total number of minutes per day.

- Which areas of the revenue management chain hold the most risk of leakage
- Which product lines represent the most revenue flow
- The relative value to the system that the different areas have

The first step in building the map is identifying the systems that are part of the revenue management chain. The systems, which include network, mediation, billing for example, should be presented as a block diagram with clearly assigned revenue management flows. Only systems that are involced in processing revenue should be included at this point.

The next step is to add up the amount of revenue flowing through each path in the revenue management chain. An example of such a diagram with traffic distribution by total minutes per day is shown in Figure 1.2.

This initial map is used to understand the relative participation of each system based on the amount of traffic that it can process. Because collections and dunning are not traffic related processes, they are excluded from the analysis at this point.

In order to assess the traffic information relevant to the scope of the study, the traffic needs to be filtered. Filtering can be done by product line, region, customer type or the type of billing activity, for example. Creating maps filtered with combinations of revenue assurance domains relevant to the study will make identifying the risk areas easier.

A traffic map is helpful for assessing system performance, but it does not tell how valuable (or risky) an area is in terms of pure revenue. For example, a data record

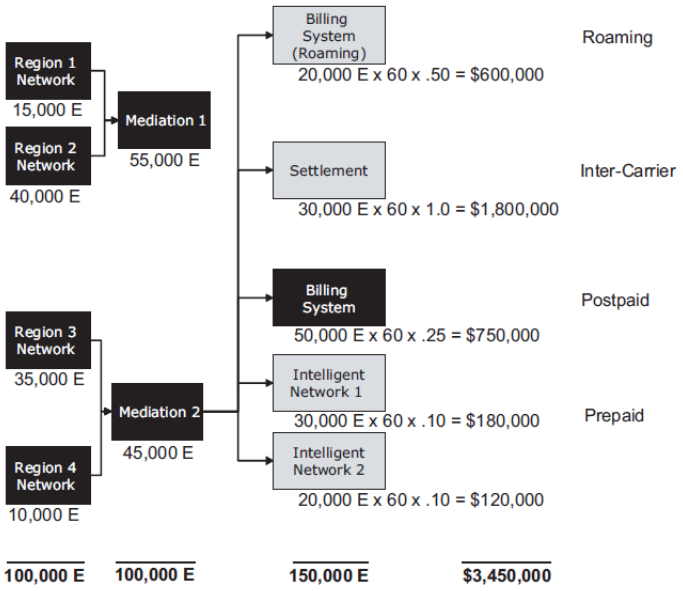

Figure 1.3: Total revenue processed by billing systems per year.

carrying price information of mobile content is many times worth a regular voice call detail record (CDR). A method is needed for evaluating the value of each part of the chain.

With call data it is possible to convert the traffic amounts in different systems into Erlangs and compare those numbers to the total revenue billed for the time period with some reservations. Problems of converting traffic into revenue include [Mat05]:

1. Customers who pay a flat rate and receive all minutes for that rate
2. Customers who pay different rates for different activity at different times
3. The addition of fees, value added services, late payments and other forms of non-minute based interaction

The last item is especially important, since this study is about mobile content. Mattison suggests, that a number of combined averaging schemes that best suit the situation are chosen for the task in order to determine an approximation of the places where revenues flow and where leakage can be stopped.

One such averaging scheme is based on an overall average value of each area on the map. The average revenue per minute is calculated for each of the different types of traffic (interconnect, roaming, prepaid, and postpaid, see Figure 1.3) and then used as a multiplier for the percentages (with an additional multiplier of 60 in this case, since 1 Erlang = 60 minutes). The resultant numbers should be compared with

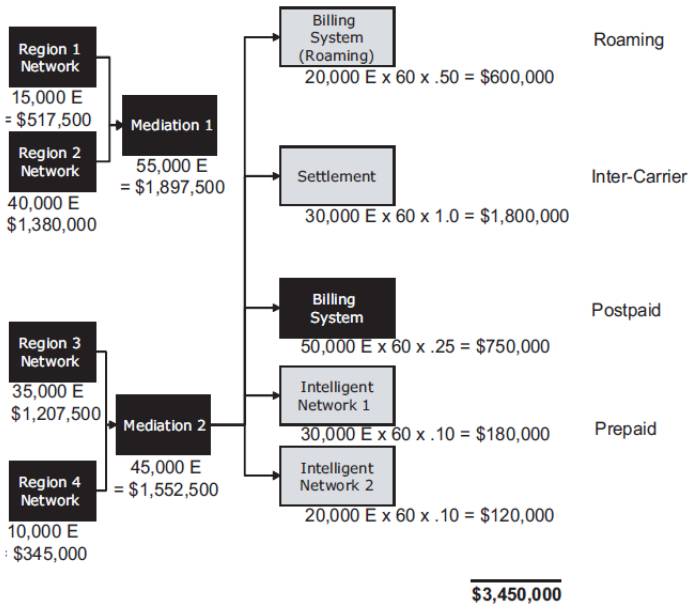

Figure 1.4: Backward applying revenue through gross averaging.

published totals of both traffic and revenue, if available, in order to make the map accurate [Mat05].

In order to get to the get an idea of the revenues in systems before billing, two options are available: detailed billing information should be used, if available, or approximation can be made through gross averaging from the totals of the billing systems. An example of backward applying the revenue is shown in Figure 1.4.

Since revenue assurance is about managing leakage (occurences, probabilitys and prevention), any strategic decision should be based on where the largest and most likely leaks are located [Mat05]. Creating the opportunity map based on the selected revenue assurance domains will give the basis for prioritizing the risk areas, while interviews with experts will be used to get another angle on the issue.

The filtered opportunity maps are built to support the goal of the study and will somewhat differ from the model presented by Mattison. The opportunity maps with information on relevant changes can be found in Chapter 3.

1.5.3 Data Analysis

Tools and Methods

The study will generate four kinds of evidence for analysis:

1. Transcripts of expert interviews

2. Documents
3. Data collected through direct observation
4. Archival records

The individual sources of evidence and the methods of collection with sample strategies are presented in the case study protocol in Appendix A. The tools used for analysis include normal office software for spreadsheet work and for organizing notes and documents.

Generalizing from Qualitative Data

While quantitative methods of data gathering offer the possibility for statistical analysis, qualitative methods have the advantage of producing a wealth of detailed information about a much smaller number of people and cases. This has the effect of increasing the understanding of the case(s) studied, but it also reduces the generalizability of the results [Pat90]. Further possibilities of reduced generalizability in this study include differing billing system implementations at operators (since only one is examined) and scarce public data of revenue leakage for making comparisons.

In order to overcome these challenges, the data collection will need be performed with care with multiple sources of evidence available to support the resulting hypothesis. While the study produces results only from one operator's billing, the goal is that the reader may estimate which results are relevant to their case even in a completely different environment.

Silverman [Sil05] lists four ways of generalizing from qualitative data:

1. Combining qualitative research with quantitative measures of populations
2. Purposive sampling guided by time and resources
3. Theoretical sampling
4. Using an analytic model, which assumes that generalizability is present in the existence of *any* case

Other methods for making generalizations of qualitative data include:

- Analytic generalization (from case study to theory) [Yin94]
  - Previously developed theory is used as a template with which to compare the empirical results of the case study
- Comparisons, Classifications, Modeling [MLJ07]

Aaltola and Valli [AV07] also suggest, that generalizations should be made from interpretations and not directly from case data.

The comparative method is the most appropriate one given the setting of the study. Silverman suggests the following by Hammersley (1992), as one of three methods that fit in this category:

- Obtaining information about relevant aspects of the population of cases and comparing our case to them

These kind of comparisons with a larger sample may allow the researcher to establish some sense of representativeness in a single case [Sil05].

As a part of within-case analysis is the inclusion of the voice and messaging revenue chain for comparisons. Revenue leakage survey results from a larger base of operators are used to compare TSF's environment to other operators and to establish some idea of generalizability.

1.6 Structure

As mentioned in Section 1.5.1, the structure of the study is adapted from Eisenhardt's [Eis89] eight step process for case studies. The different phases and their relation to the chapters of the study are presented in Table 1.3.

Chapter 1 is the introduction and background to the study and it covers the three first phases of Eisenhardt's process. In Chapter 1 the scope and methodology is defined with consideration on how to answer the research question and to how maintain a chain of evidence from questions to conclusions. Details on methodology used to collect different kinds of evidence can be found in the case study protocol in Appendix A.

In Chapter 2 revenue assurance as a part of a mobile operator's business is explained. The chapter contains information about the history of revenue assurance, it's practices in a bit more detail than when defining the scope and the status of corporate revenue assurance functions at TSF.

Chapter 3 will introduce the current types of mobile content with the delivery and billing models that are used with some examples. The delivery and billing chains involved will be examined by both their contractual and technical aspects. Information is gathered through open-ended interviews and documents for building the technological and logical map of the billing systems, which will serve as the basis for the opportunity maps. The opportunity maps are then generated and explained. The interviewees are key personnel from TeliaSonera including project managers,

system specialists and revenue assurance personnel. The full list of interviewees can be found in Appendix B.

In Chapter 4 the risk areas and their priority on both voice and mobile content chains will be defined based on the survey results, opportunity maps and expert interviews. The specific questions asked of interviewees can be found in the case study protocol (Appendix A).

Chapter 5 shows the summarized results of the study with a note on the generalizability of the results and a hypothesis based on the analysis of the results.

In Chapter 6 conclusions are drawn and suggestions for the mobile operators and recommendations for further study are presented. The chapter also includes an assessment of research validity.

Table 1.3: Structure for a theory-building (hypothesis-generating) case study

Structure	Phase	Action	Observations and Methods
Prestudy and Chapter 1	Getting Started	Defining the research question	Discussion with supervisor, instructor and colleagues and narrowing the scope based on prestudy of the subject
Chapter 1	Selecting Cases	Neither theory nor hypotheses Specified population	Through literature review, history and obtained background information Vertical and horizontal domains in operator
	Crafting Instruments and Protocols	Defining several methods for data collection incorporating both qualitative and quantitative data	Methodology selection and revision based on research questions and background information. Triangulation of collected data through multiple methods.
Chapters 2–4	Entering the Field	Overlap data collection and analysis, including field notes Flexible and opportunistic data collection techniques	Data collection and analysis through the case study protocol Interviews, documents, archival records, direct observation
Chapter 5	Analyzing Data	Within-case analysis	Revision of evidence through qualitative and quantitative analysis methods for preliminary theory creation
	Shaping Hypotheses	Iterative tabulation of evidence for each construct Search evidence for "why" behind relationships	Assessing the evidence in order to answer the research question Building internal validity
	Enfolding Literature	Comparisons to opposing and conforming literature	Strengthen internal validity and sharpen construct definitions
Chapter 6	Reaching Closure	Theoretical saturation when possible	Conclusions and suggestions for further research

Chapter 2

Mobile Operators and Revenue Assurance

This chapter will describe what revenue assurance is according to definitions and chart a scope for the work, in which revenue assurance issues are examined. In addition to the terms and practices discussed in Chapter 1, some differing views and definitions on revenue assurance are examined in this chapter. We will also take a glimpse at the history of telecommunications operators and how the term revenue assurance came to be. Finally, the current status of revenue assurance is explained with an introduction to corporate level revenue assurance at TeliaSonera Finland.

2.1 Overview

2.1.1 Revenue Assurance and Revenue Leakage

The term *revenue assurance* is associated with the field of telecommunications and it deals with issues related to *revenue leakage*.

Definition of Revenue Leakage

Revenue leakage, as defined by Cartesian [Kre06], is:

> The difference between the actual revenue billed to valid customers and the total billable revenue, assessed at a given moment of time.

Mattison [Mat05] gives a simple definition for a leak:

> A "leak" is when a telco service is delivered, but not billed and collected

> on. As time goes on, many telcos are finding more leakage in their operations, not less.

As for why revenue leakage happens, there are many possible reasons in a telecommunications operator's billing environment. Technical problems can surface easily when dealing with several ordering and billing systems. Since subscriptions can be taken in by phone or at operator outlets, there is room for human error as well. In fact, since product and user details are added into the systems by hand, the margin for error may be greater in daily operation than with any technical faults in the systems. A subscriber's details might be entered incorrectly by the person taking in the order preventing proper billing even if the billing process is otherwise functional. Internal and customer fraud are also possible sources of revenue leakage.

Sometimes it can be very difficult to find the real source to a detected problem, even if the operator has a comprehensive list of causes. For example, if there were unbilled usage of the network, the reason could be anything from faulty network equipment to intentional fraud. The root cause would determine which team would handle the problem or whether anything could be done about it at all.

The TeleManagement Forum's Revenue Assurance Guidebook [Tel06] has identified three categories of revenue leakage:

- Fraud
- Bad debt
- Operational inefficiencies

Fraud issues include both internal and external events, where services are used illegally. Bad debt means the portion of receivables, that can no longer be collected. In the context of revenue leakage it can be a customer who refuses to pay, for example. Operational inefficiencies account for all process and data quality related problems, which lead to lost revenue. This is the domain where revenue leakage will be examined in this study, as operational inefficiencies can usually be resolved to a higher degree than other causes of revenue leakage.

Definitions of Revenue Assurance

In addition to the concepts of disciplines, domains and levels in Section 1.4, differing views of the overall function of revenue assurance are presented below.

The TeleManagement Forum has defined revenue assurance as follows in its 04/2005 Revenue Assurance Overview [Tel05a]:

> Data quality and process improvement methods that improve profits, revenues and cash flows without influencing demand.

The Revenue Assurance Guidebook by the TeleManagement Forum [Tel06] states, that revenue assurance should perform a thorough evaluation of the operator's every domain to ensure there are no leakages at a process as well as technology level. Revenue assurance is also about risk assessment and risk management with respect to processes that support revenue management chain and collateral areas.

Cartesian [Kre06] defines revenue assurance as:

> Any activity an organisation performs to ensure that processes and systems result in complete, accurate, valid and timely billing and collection. Largely synonymous with activities that in different organisations may be called cost and revenue assurance, margin assurance, contribution assurance, etc.

Although all sources agree, that there is some confusion about the scope of revenue assurance, the definitions suggest, that revenue assurance goes beyond simply reacting to detected leaks.

This study will use the definitions of Section 1.4, unless otherwise noted.

2.1.2 History

Three factors played a role in the emergence of revenue assurance among telecommunications carriers following the rapid business expansion in the 1990s. The focus shifted from quick fixes to processes and organisational structuring in order to survive the global depression and to remain profitable. While business costs went up and revenues went down, there was a constant push to keep up with new technology. These factors coupled with the market demand for new services was enough to start addressing the problems under a common term - *revenue assurance* [Tel05a].

Many things revenue assurance seems to address, when dealing with revenue leakage, are not new to the telecommunications industry. While revenue leakage might have been a "cost of doing business" earlier, as Mattison puts it, improvements of even a few percentages can have major impact on how the company is perceived by today's tough marketplace, investors and regulators. With the exponential growth of products, technologies and business models, a greater need for revenue assurance is emerging and it is being perceived more as a necessity than a luxury in an environment where so much is changing so quickly [Mat05, Mat07b].

Reasons for putting more effort into revenue assurance today include [Mat05]:

Regulatory Pressure Many operators are already under some scrutiny from National Regulatory Authorities (NRA) and also regulations related to the Sarbanes-Oxley Act (SOX). Revenue assurance practices overlap with many regulatory demands and maintaining integrity through established RA practices reduces the load of regulation.

Profit Pressure The competition between operators is fierce and any possible way to increase earnings is in the interest of investors and shareholders.

Merger Pressure When multiple mediation, billing and other systems from disparate companies are forced to work together, it is increasingly difficult to keep errors out of the revenue management process.

Convergence Pressure The gradual migration towards a convergent environment increases pressure on existing systems, which generates more errors and risks.

Innovation Pressure With a seemingly endless stream of new products, technologies, billing methods and price plans on the horizon, revenue management without an established revenue assurance function will be an impossible task to handle.

2.2 Problems with Implementing Revenue Assurance

2.2.1 Legacy of the 1990's

The need for revenue assurance processes was recognized in the 90's, but there is still a lot of work to be done at operators to reach any level of process maturity. Much of this is, because many employees are still used to working with short term goals. Organisational restructuring and cost reductions also serve to separate employees from long term development [Tel05a].

Even without pressure from shareholders to cut costs and increase profitability, revenue assurance as a theory is still in its infancy without many concrete results. If a revenue leak is fixed, it might not seen as increased profit, because [Tel05a]:

- There was a cost to fix the leak
- The revenue would not have been lost in the first place without the leak
- The effect of the fix cannot be immediately measured
- Lost revenue isn't always or cannot be retroactively recovered

This presents a problem to financial management, which has to decide how much to invest into revenue assurance. How do you justify the fixed costs of revenue assurance to the business, when the benefits might not be measurable at all [Tel05a]?

2.2.2 Regulation

Revenue assurance processes are seen as a burden much in the same way as regulatory constraints, even though both share some positive effects. Indeed, some regulatory needs can be addressed by a comprehensive revenue assurance function. Examples of this are [Tel06]:

- Risk assessment across revenue management chain and collateral processes
- Data integrity for financial reporting purposes
- Detection of leakages at system integration points
- Evidence for internal control evaluation and documentation

2.3 Corporate Revenue Assurance at TeliaSonera

The Revenue Assurance function for the entire TeliaSonera Group is controlled through the Corporate Management function. The unit is referred to as Corporate Revenue Assurance (CRA) and it is placed directly under the CFO. The CRA group reports to CFO directly for the entire TeliaSonera Group and also communicates through a Corporate RA Steering Group Committee made up of top management personnel. Each steering group member is elected and approved for chair positions.

The responsibility for revenue assurance and any related developments within the TeliaSonera Group is managed by the CRA unit. All activities within any part of the group are to be advised, reported and approved through CRA. CRA has been implemented officially in TeliaSonera as of January 1st, 2008. CRA are working today in deploying common RA routines and objectives within each of the country bases.

2.4 Summary

Revenue assurance as a corporate level activity is becoming more and more important for operators with the emergence of new products, technologies and billing models.

The scope of this work will focus on the mobile content revenue chain of TeliaSonera Finland and revenue leakage from operational inefficiencies using definitions of revenue assurance presented in Section 1.4.

Chapter 3

Building the Opportunity Map

The opportunity map (described in Section 1.5.2) will be built by obtaining information from the systems involved in the revenue management chain, based on the chosen revenue assurance level and domains defined in Section 1.4. Order management and roaming are included in the analysis, but not on the opportunity map itself since they affect the revenue flows only indirectly.

3.1 Mobile Content

This section will explain the types of mobile content available to consumers, how to order it and how it is billed. The interface products offered to service providers are also examined along with the order management and processing of service provider agreements. Flow charts will be used to illustrate both delivery and billing mechanics in TSF's systems.

Sections 3.1 - 3.3 will describe the logical and technical functionality of:

- Mobile content billing and delivery
- Regular priced voice billing
- Regular priced messaging billing
- Roaming and its relation to voice and mobile content

3.1.1 Types of Mobile Content

Mobile Content for Consumers

Mobile content is something that you use and access with a mobile handset and there is a variety of services available for the consumer - both free and commercial. Considering the capabilities of a 3G handset, there are three ways of accessing content:

- Voice
- Messaging (SMS, MMS)
- Data (WAP, Internet)

Commercial voice services are usually premium rate numbers, where the caller is charged by call, by minute or by a combination of the two. There are also services, where you can use a premium rate number to pay for something else like soda from a vending machine. While dialing a number would be a valid method for paying for mobile content like a ringtone, it is simpler to implement such services through messaging and data services alone. Hence, for the purposes of this work voice based content services are not included in the scope.

Messaging services are currently bringing in the most revenue from mobile content services. One reason for the popularity of messaging as a payment method is its simplicity for a large base of users. After the huge growth of SMS messaging in the end of the 90's and during this decade, it has become an everyday tool for mobile users all around the world. Messaging also enables charging for many types of content so the services provided through messaging are not limited to just text or images, that can be sent back. An example of such a transaction is to send a WAP link as a reply to the subscriber, who orders a mobile game through messaging. Thus the charging is handled via messaging, but the actual content will be free to download after receiving the address (excluding the data transfer charges of the operator).

WAP content can be accessed and charged in other ways too. In fact, while the bias is heavily in favor of messaging for the charging of mobile content, the charging can be done via WAP as well. From the subscribers' viewpoint it is as simple as navigating WAP pages and selecting items for purchase, if the content provider has made a WAP billing agreement with the operator. For ease of use, operators often bundle both free and commercial services under their own WAP portal, which subscribers can access after receiving the operator's connection settings to their handset. TeliaSonera Finland's WAP portal is called Sonera SurfPort and it can host the following types of services [Tel05b, Tel05c, Tel05d, Tel09]:

- Weather information
- Mobile games, applications, ringtones, logos and screensavers
- News and sports services, bank services, MobileTV
- Traffic information, downloadable navigator application, public transport schedules
- Search engines, dictionary
- Links to health information, holidaymaking, restaurants and dating services

Most of the content is designed to be used on the fly and the generic news services are free. Users requiring specific information may opt to pay for detailed weather information, for example. Games and applications on the other hand usually always come with a price.

Even the premium services accessed via WAP can mostly be found for free on the Internet. Since 3G handsets come with a HTTP capable browser, some users may never even see a WAP page. Finding something specific for mobile handsets with limited readability will most likely take a longer time, than purchasing the same service via a WAP portal. It is a challenge to the content developers and operators alike to find a balance between traditional telephony, where everything has a price, and the Internet, where practically everything can be found for free.

TSF Products for Content Providers

From an operator's viewpoint the different content services are implemented through interfaces, that enable certain types of transactions. TeliaSonera Finland is offering four products for content providers:

- Messaging Interface
- WAP Interface
- Ring-back-tone Interface
- Mobile TV Interface

While there may eventually be a lot of new types services utilising the Ring-back-tone, Mobile TV and other interfaces in the future, practically all of the revenue from mobile content is due to the Messaging Interface and the WAP Interface at the moment. These two content provider products act as the basis for exploring revenue assurance functions around mobile content in this work, while the rest are left out of scope.

Messaging Interface

The heart of operations for the Messaging Interface at TSF is the Content Gateway (CGW). The CGW acts as a connection point for content providers, subscribers and billing systems. The CGW includes tools for the Messaging Interface's services and features: text- and mobile multimedia messaging, different service types and billing features, the Location info service and the CGW monitoring service.

In order for a content provider to offer messaging services through TSF, they must first sign a Messaging Interface agreement, which also includes an optional billing agreement. The Messaging Interface agreement is part of the Sonera Service Provision Solution, which may also include a WAP Interface agreement and Sonera SurfPort connectivity. The content provider must then configure their end of the service to work with one of four types of operation supported by the CGW [Tel04]:

- Send only (the service only sends messages to mobile terminals, messages cannot be charged from the subscriber)
- Receive only (the service only receives messages)
- Query / Reply (the service receives messages and replies with either an SMS or MMS message to the originating mobile terminal)
- Push (the service sends premium priced messages to the mobile terminal, requires subscription)

All of the service types support both SMS and MMS messages. The *Send only* service type cannot be used to offer a premium price service, as it requires no subscription. The other service types can be charged with premium prices in successful transactions[1]. Since it is defined in the Messaging Interface agreement, that the content service must be made according to TSF specifications, billing errors due to misconfiguration in the content provider end are left out of the scope of this work.

Examples of services implemented with the Messaging interface [Tel05b]:

- Premium rate text- and multimedia messages
- Mobile device personification: ring tones, wallpapers, screensavers, logos
- Entertainment: horoscopes, jokes, chats, adult entertainment
- Informative services: schedules, maps, event calendars, catalogues, databanks

[1] A successful transaction depends on the service type, but faulty messages (errors either in the content of the message or the receiving number) sent by the end user are never charged premium price.

- Informative services based on fast changing events: news, financial information, stock quotes, sports results
- Marketing (direct marketing requires the end users' written consent)
- Transactional services: customer service-, ordering-, billing, and service channel
- End user location based services

WAP Interface

The functionality of the WAP Interface is implemented through TSF's WAP Gateway (WAPGW), which routes the data connection from the end user's mobile terminal to the content provider's WAP pages and also forwards billing information.

The WAP Interface agreement is similar to the Messaging Interface agreement and it must be signed by the content provider in order to offer WAP services through TSF. Differing from the Messaging Interface agreement, the object of the agreement must also be specified according to the following terms:

- Billing service and reporting
- Transmission of end user mobile phone number (MSISDN)
- Transmission of location data (Billing service and reporting must be ordered)

The billing service for the WAP Interface is based on transactional billing defined by the content provider. Time based billing is also possible, but only if the content provider implements subscription and payment management by themselves. The content provider determines the billing transactions to be invoiced for in the header information of the transaction's HTTP file and is also responsible for the validity of the information. The services must be grouped for service barring according to the technical instructions of the WAP Interface agreement. Service barring is governed by the appropriate, valid regulation of the Finnish Communications Regulatory Authority. TSF will invoice and settle only successful service transactions based on TSF's statistics and systems. Thus, the content provider's end is once again excluded from the scope of this work.

The transmission of the end user's location data is also possible within the HTTP transaction headers. The information is transmitted when the end user starts a service utilising location data on the content provider's WAP page. Since the location data is based on the the density of the base station network and on the size of the cell coverage area, the positioning accuracy can vary from several hundred meters to

kilometers. The location data can also be transferred for services using the Messaging Interface with the same restrictions on positioning accuracy.

The end user's mobile phone number (MSISDN) can be transmitted to the content provider's server. The number may be transmitted in connection with a HTTP enquiry, if the transmission service has been agreed on in the service agreement. The end user's mobile phone number is not transmitted in services that utilize location data [Tel05e].

Examples of services implemented with the WAP Interface [Tel05c]:

- Various entertainment and information services, such as ring tones, logos, games, news, weather, financial information, event calendars, horoscopes, etc.
- Marketing and customer service solutions, such as a feedback, enquiry or service channel, or a distribution channel for regular customer services (e.g. account balances, special offers, latest information)
- Communal services: checking the forthcoming events, timetables and latest news
- Services based on the end user's location data

3.1.2 Ordering Mobile Content

Services Using the Messaging Interface

In order to understand the billing processes involved on the operator's side, the ordering process will be examined first. In the case of prepaid subscriptions, there is an additional step of checking the balance of the prepaid account before transactions can be made. Figure 3.1 shows an overview of the main system components used when ordering content using the Messaging Interface.

For regular priced SMS and MMS messages the account balance check is performed by the Signaling Gateway (SGW) from the Intelligent Network (IN) database in real time each time a message is sent. If the destination number is not a premium rate number, the SGW deducts the normal message price from the IN database and sends the message forward. If the balance of the account is not sufficient, the SGW refuses to forward the message. Messaging and voice billing or regular priced numbers is further examined in Section 3.2.

If the SGW determines the destination number to be a premium number, the charging is delayed and the message is forwarded to the Content Gateway (CGW). The CGW checks the subscriber number from the message to find out whether it is a prepaid or a postpaid subscription. The CGW makes a reservation to the IN database

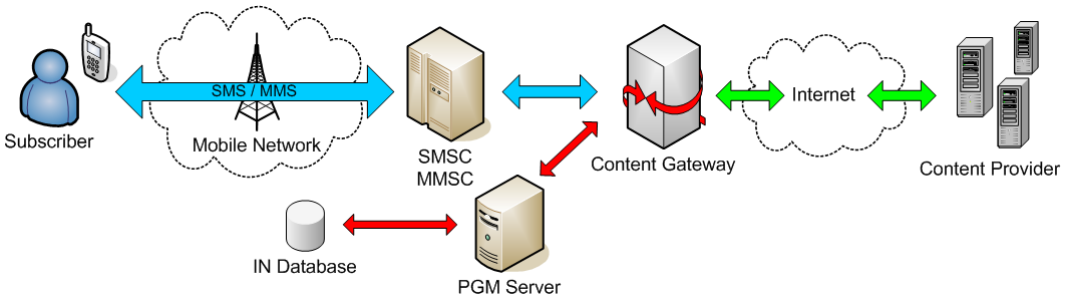

Figure 3.1: Main network components between the subscriber and the content provider with messaging.

according to the maximum service price of the content provider in question (checked from the destination number) and forwards the message to the content provider. After the content provider acknowledges the service transaction and replies with the price, the CGW returns the possible overcharge back to the prepaid account's balance in the IN database and forwards the possible reply from the content provider to the subscriber. The PGM server acts as a mediator to queries made to the IN database.

With postpaid subscriptions there are no account balance checks. Instead, when the CGW receives the service price from the content provider, it adds an identifier to the data record which is passed on to the billing systems where the transaction ends up on the subscriber's monthly bill.

Services Using the WAP Interface

Figure 3.2 shows an overview of the main system components used when ordering content using the WAP Interface. The traffic is routed through WAPGWs (there are several as opposed to the single CGW). While CSD connections are still possible, most users will be using a GPRS data connection for WAP services.

With a GPRS connection the prepaid account balance is monitored in real time by the SGSN and the SGW mobile network components, making deductions in blocks to the balance in the IN database according to the transferred amount of data. When the data connection is terminated, any overcharge is returned to the prepaid account.

The WAP Proxy performs the account balance check from the IN database with premium services. If a prepaid subscriber's balance is sufficient for the highest priced service on the content provider page, the traffic is allowed. When the charging event is generated and communicated to the WAP Proxy, the WAP Proxy forwards this information to the IN database and the price of the service is deducted from the subscriber's balance.

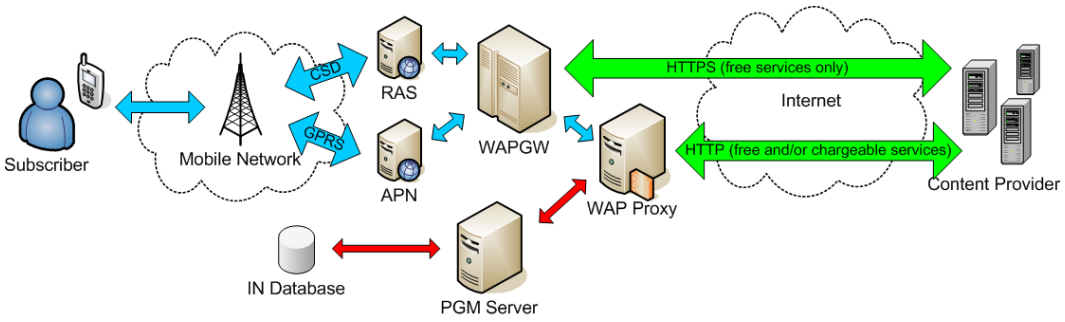

Figure 3.2: Main network components between the end user and the content provider with WAP.

With postpaid subscriptions the ordering process is similar to prepaid, but there is no account balance check involved. Instead, the WAPGW adds an identifier and sends the data record containing the subscriber number and service details to the billing systems where it is rated and added to the subscriber's monthly bill.

Service Provider Order Management and Processing

The Service Provider order management and processing for the Messaging and WAP Interface products are managed by the CMC team. The CMC team receives interface agreements either from corporate sales or from straight from the service provider.

The service provider agreement will be activated by the internal product order made by the CMC team. The CMC team is responsible for the activation of the technical and billing portions of the agreement so that there will be no unnecessary unbilled traffic. Unnecessary traffic can be detected in daily reports and it is examined further when appropriate.

In case of a new customer the CMC team enters the company info to the enterprise customer database, which also acts as an enterprise customer master to all billing systems. If the customer already exists, additional information concerning the new interface agreement will be entered. The enterprise customer master has an interface to the mobile content rating and billing system, through which it communicates service provider information for billing.

Once the content rating and billing system receives the service provider information from the enterprise customer master it is further processed in the content rating and billing systems's customer and order management subsystem. The billing accounts are created with appropriate billing information and addresses and the actual payment generating products are ordered to the accounts based on the identification and prices defined in the agreement.

If an appropriate rating plan for the customer isn't found in the content rating and

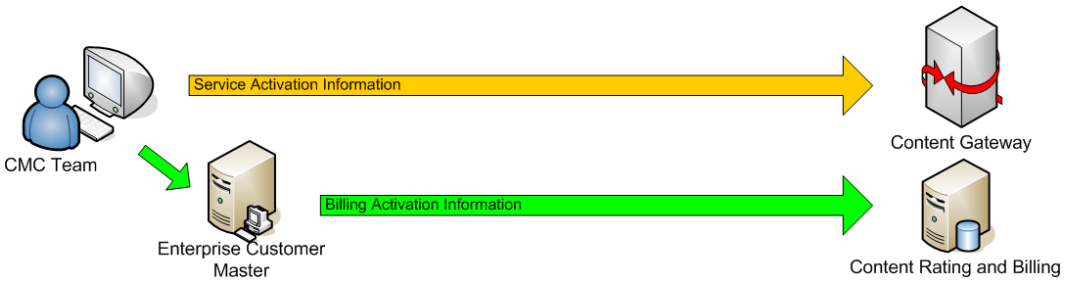

Figure 3.3: Service Provider order management.

billing system, the CMC team will order one from the billing team. The billing team will define the rating plan, test it before sending it to production and notify the CMC team that the rating plan is available for orders.

Subscriber order management and connections to consumer billing with voice and messaging will be examined in Section 3.2.

3.1.3 Content Billing Models

TSF Content Billing and Revenue Sharing

Both WAP and Messaging Interfaces use the same content rating and billing system. An overview of the flow of data records is shown in figure 3.4. The content rating and billing system also manages other inputs (some of which only pass through), that are not displayed here for clarity, for example MMS messages from the MMSC. All premium number message transactions enter the system prerated at the service provider from the CGW, while WAPGWs send unrated data records, that are rated later in the chain.

The mediator is responsible for merging the output from different source platforms into a common form. The source platforms (CGW, WAPGWs, others) generate an identifier for the data records they send into the billing system and the mediator adds its own identifier to each data record. The data records are passed on to the preprocessor, which performs several actions based on the content of the data records.

The main function of the preprocessor is to detect which data records can and should be rated at the main rating and billing system. In the case of prerated data records from the CGW, the data records are exported to the mobile network billing systems to be added to the subscriber's monthly bill. The preprocessor splits the content provider's share from the data records and also splits them further, if there are more than one VAT percentage applied to one event, for example. WAP data records are handled in the same way, but since a lot of the data records that reach the

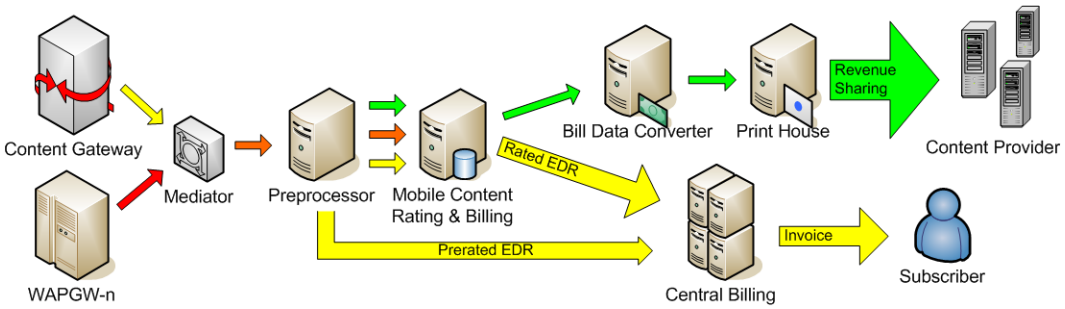

Figure 3.4: Content rating and billing overview.

preprocessor cannot or should not be rated in the system, there are four stacks where discarded data records can end up:

- Filtered (data records not from any configured platform)
- FLT (data records, that cannot be rated due to missing information)
- Not rated (data records that contain data, which proves they should not be rated in this system)
- Error (data records that contain an error, which can be allocated to a specific error code)

The preprocessor uses a control list from the rating and billing system to find out whether there is a billable account and an appropriate rating plan for each data record. If the content provider's billable account was mistyped in the rating and billing system, the preprocessor would detect that there are data records that should be rated in this system, but cannot be linked to a billable account. The data records would then end up in the *FLT* stack to be reviewed in a weekly report generated by the system. The *Not rated* stack contains mostly WAP traffic data records and in normal operation there should not be any data records that end up in the *Filtered* stack. The *Error* stack contains data records, which may be missing a header field, for example. Some of these data records can be rerated depending on the error type, but others may be too malformed to rate.

Once the split data records reach the rating and billing system, they are rated and the end user's billable part is sent to the mobile network billing systems, except for prerated data records from the CGW, which were sent forward earlier at the preprocessor. The content provider's share (also from prerated CGW data records) is sent to the bill data converter monthly, which combines the billing information before sending it forward to the print house.

3.1.4 Mobile Content Summary

Mobile Content Scope

The scope of the work includes two content provider products from TSF and the associated consumer services, namely the Messaging Interface and the WAP Interface. Only service providers which have arranged their content billing through TSF are considered in the analysis. This limits the subscribers to either Sonera or TeleFinland brands, since other operators have their own arrangements for mobile content providers.

Mobile Content RA Points of Interest

- Technology
  - Nonbillable WAP traffic data records are carried all the way to the preprocessor, where they generate most of the mass of the *Not rated* stack possibly hindering the detection of other erroneously nonrated data records
  - The rating and billing system has no way of recognising faulty input of account information
  - If there is a billable account, but no price for the service, the preprocessor does not notice this from the control list
- Processes
  - There is a weekly review of the *FLT* stack, which is done manually
  - Possible inefficiencies at the ordering support (entering account and rate plan information into the rating and billing system)
- People
  - Responsibility areas

3.2 Voice and Messaging

In this section regular voice and messaging will be examined through flow charts and consumer billing system functionality in order to make comparisons with the mobile content revenue chain. The voice and messaging revenue chain's systems also handle mobile data traffic, which has an effect on the total traffic amount. Subscriber order management and processing systems and their relation to the central billing system will be added to the system charts to get a clear picture of the whole billing and delivery network for voice, messaging and mobile content.

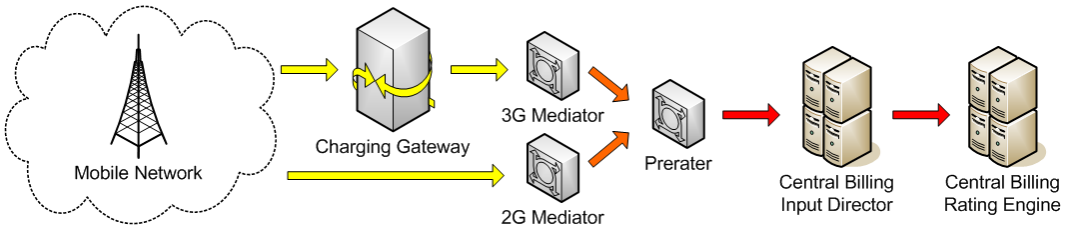

Figure 3.5: Regular priced voice and messaging data record flow chart.

3.2.1 Regular Priced Voice and Messaging

Overview

Mobile voice and messaging are everyday activities in both company and consumer segments. While the usage, billing and ordering scenarios differ greatly in these two segments, only the consumer segment will be examined. This is to ensure compatibility with mobile content usage scenarios, where the subscriber is usually a consumer. No distinction will be made between making calls (or sending messages) in a 2G or a 3G based mobile network, with the exception of a few network components before mediation to the billing systems.

The billing and rating for regular voice and SMS messaging from both 2G and 3G mobile networks is handled by the central billing system. The central billing system itself is a complex entity consisting of components for billing and rating with interfaces to over twenty other systems. For simplicity and relevance to the scope of the work, most of these components and interfaces are omitted. Figure 3.5 shows a simplified data record flow chart for regular voice and messaging.

2G voice and messaging CDRs reach the 2G mediator from the MSC, which sends them to the prerater. The prerater forwards the CDRs to the central billing input director, which sends them to the rating engine where they are rated.

3G data records are first processed through a charging gateway, after which they are sent to the 3G mediator. The rating and billing happens in the rating engine similar to 2G CDRs.

MMS messages are rated in the central billing system as well, but they enter central billing through the mobile content revenue chain.

Billing

For prepaid voice traffic the IN monitors the subscriber's balance in real time and makes subtractions to the balance during the phone call. The IN signals to terminate the phone call when the balance reaches zero. Phone calls are prevented, if the

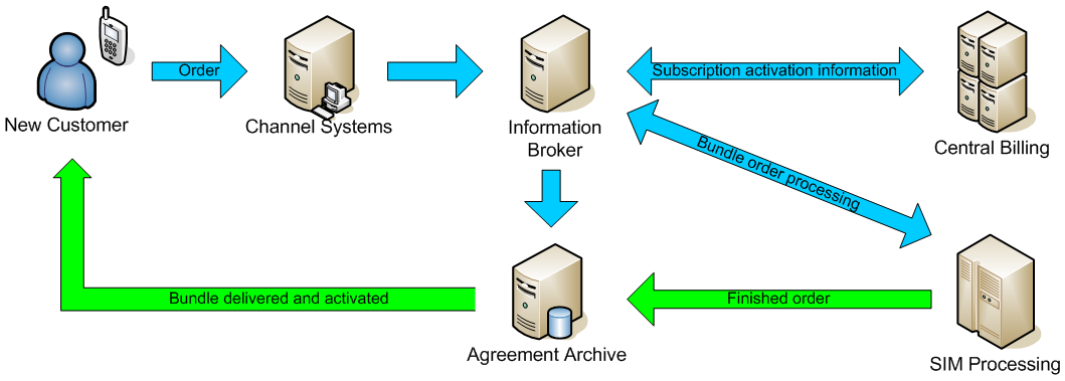

Figure 3.6: Bundled subscription order process for consumers.

balance of the subscriber's account is too low for dialing the number. Emergency phone calls are allowed regardless of account balance.

SMS and MMS messaging follows the same priciples as voice with prepaid subscriptions. The IN checks whether the subscriber's balance is sufficient for sending the message before making the subtraction to the account and forwarding the message.

Postpaid subscriptions follow the path described in the overview when making mobile calls and sending messages.

3.2.2 Subscriber Order Management and Processing

Overview

The order management and processing for service providers is managed by the CMC team as explained in Section 3.1.2. The order management and processing for subscribers is slightly more complicated because of sheer volumes, different segmentation and handset bundling. Since mobile content is associated mostly with newer mobile phones, the order and delivery processing for subscribers will be examined for bundled subscription orders.

Bundled Subscription Ordering

The bundled subscription ordering process for consumers is illustrated in Figure 3.6. When a customer makes an order for a new bundled phone and subscription, the information is first received by sales personnel and entered into channel systems, which manage customer orders and also perform credit checks. Depending on whether the customer needs a SIM card, the order preprocessing system contacts the central billing server and the SIM processing server. If a new SIM card is needed, the subscription is preactivated at the central billing server. A bundled subscription

preorder request is sent to the SIM processing server. The agreement archive is also notified of the success or failure of credit checks and subscription preactivation.

Next the bundled subscription delivery process is started in the SIM processing server and when the subscription is ready to be activated, the information is sent back to the information broker system. The information broker system processes the information and sends the activation request to central billing. The central billing system processes the request and sends a response back to the information broker system for validation. The activation response service then contacts the SIM processing server with the reply. If the activation is unsuccessful, the SIM processing server halts the order. In case of a successful activation the profile information in the agreement archive is updated and the bundle is activated and delivered to the customer.

3.2.3 Voice and Messaging Summary

Voice and Messaging Scope

For regular voice and messaging only consumer subscriptions are included in the scope to ensure compatibility with mobile content billing, where the customer is usually a consumer.

The rating and billing of mobile voice and messaging are more straightforward than mobile content and most of the functionality involved is focused on the IN and the central billing system. The billing mechanics of both mobile voice and messaging are included in the scope of the study for comparison purposes.

New customers will likely order a bundled subscription package, which has several steps for entering the customer data into the central billing system and delivering the package to the customer. While there may be errors in the customer data in the central billing system, further analysis of this function is left out of the scope of the study, since it is not directly a part of the revenue management chain. If the expert interviews suggest a deficiency in the customer data, the process will be examined in more detail.

Voice and Messaging RA Points of Interest

- Technology
  - CDR volumes and revenue chain components
- Processes
  - Controls and processes used in detecting leakage

- People
  - Responsibility areas

3.3 Roaming

3.3.1 Terms and Definitions

TSF has roaming agreements with about 300 foreign mobile operators. The roaming agreements and the required rating and billing information are managed through the central billing system's roaming follow-up functions. The exchange of roaming events is managed by an outside broker, which is a data clearing house (DCH). The DCH manages and transmits billing information between operators all over the world.

Inbound roaming is defined as some foreign operator's subscribers using TSF's mobile network. The visitors' billing events are rated in the central billing system by TSF's inbound rating plan and sent through the DCH to be billed by the involved foreign operator. A roaming invoice is generated monthly as a summary of a foreign operator's roaming events in TSF's mobile network. The invoice is used for inter operator traffic adjustments.

Conversely, outbound roaming means TSF's subscribers using a foreign mobile network. All the roaming events of IMSIs in foreign networks with a TSF defined prefix enter the central billing system through the DCH. Sonera's and TeleFinland's subscriber events are billed in the central billing system, while other service operators' billing events are distributed to the operators in question.

The prices of international roaming events are determined by inter operator tariffs (IOT). The foreign operator charges the home operator by their own IOT rating plan. The IOT is compensation for transmitting voice and messages to the recipient in the foreign mobile network. IOTs are not reciprocal; each mobile network operated defines their own IOT rating plan. The inter operator tariffs are regulated between EU countries by a Code of Conduct principle. In TSF's implementation the CoC roaming agreements are grouped under their own rating plan in the central billing system.

3.3.2 DCH and the Connection to Central Billing

Roaming data for both outbound and inbound roaming are sent through the roaming input director, which translates the ticket data into a format the DCH and the central billing rating engine can use (figure 3.7). Inbound ticket data is updated frequently, while outbound roaming tickets are sent to the rating engine three times a day.

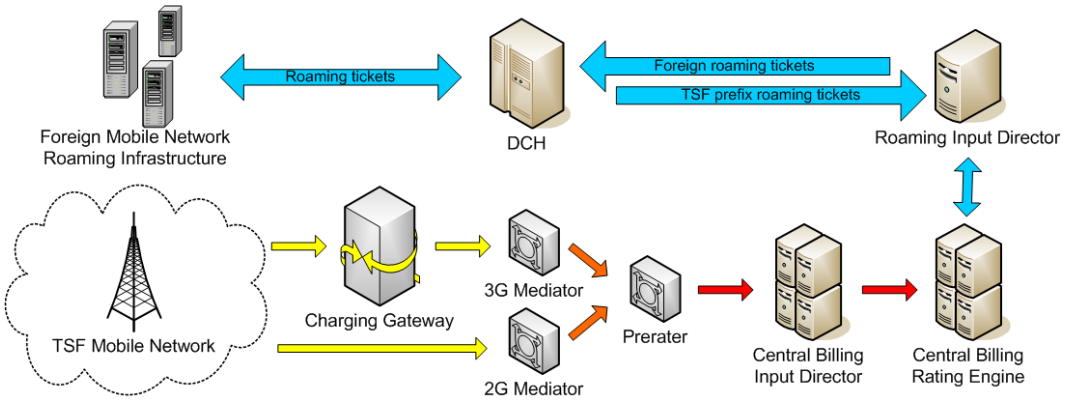

Figure 3.7: DCH and the roaming input director connected to the central billing system with local mobile network voice and messaging data record flows.

Outbound Roaming

Roaming tickets from the DCH are prerated with a wholesale price from the foreign operator and in some cases with a TSF specific end user price. The central billing rating engine calculates end user prices for the following events:

- Calls abroad for operator specific pricing
- Calls received abroad
- Messaging abroad
- GPRS data transfer

The DCH rates the end user price for outgoing voice and circuit switched data based on a rating plan provided by TSF. The DCH prerated end user prices are used to bill consumer subscribers without further processing. Video calls abroad are billed with the prerated (normal) call price plus a minute based charge, which is calculated at the rating engine. Messages sent abroad use a global price, which is also applied at the rating engine.

For calls received abroad the rating is done by the rating engine based on ticket flags from the DCH. The end user price is determined on a zone[2] basis.

GPRS events abroad are priced in the rating engine by amount of transferred data. WLAN usage is charged by duration.

[2]Countries are grouped under 6 zones globally.

Inbound Roaming

The central billing system differentiates subscribers from foreign operators by IMSI numbers. Visitor tickets from TSF's mobile network are separated from TSF's own tickets and rerouted to be processed as inbound roaming events in the central billing system.

Voice, data and messaging events for visitors are rated with a roaming charge. Circuit switched data calls are charged with an added fixed price. If the visitor's operator is one of the countries with CoC agreements, the CoC price is used. If the operator is not listed on the CoC rating plan, an operator specific rating plan is used. If the operator is not found at all, a generic IOT rating plan is applied to the roaming events.

GPRS data traffic is rated by the amount of data on the tickets. Tickets belonging to the same connection are merged before rating and forwarding. The data traffic events are priced by the total transferred data of the connection. As with outbound roaming, WLAN traffic used time based charging and is usually the same for all visitors.

3.3.3 Roaming and Mobile Content Ordering

Outbound Roaming

Since outbound roaming scenarios in most cases do not include transactions with service providers, whose billing is managed by TSF, the impact of possible revenue leakage is minimal in the context of this work. Thus mobile content ordering in outbound roaming is not examined further than to note, that the messaging and data transfer part of successful mobile content transactions in foreign networks should arrive to the DCH with the appropriate pricing information.

Inbound Roaming

Visitors in TSF's network face the same issue as TSF's outbound roaming subscribers. Since service providers must have a separate agreement with each operator they wish to do business with, it is unlikely that local mobile content services will work for visitors. It should be possible to order content from some WAP pages (which have an agreement with the visitor's operator), but such a transaction may be considered a rarity in the scope of the study and it will not have a meaningful effect on issues related to revenue assurance in this area.

3.3.4 Roaming Summary

Roaming Scope

Roaming adds another dimension to the revenue assurance problem. However, with the way service providers need to manage their billing agreements with each operator separately, the whole aspect of roaming is practically eliminated for mobile content revenue assurance in the scope of this study.

For voice and messaging roaming is a valid issue, but since we want to compare the billing mechanics to those of mobile content, roaming is not included in the scope of voice and messaging either. The only way (inbound) roaming tickets affect the billing mechanics is, that the visitor CDRs travel through the same systems as local subscribers'. Whether the amount is of any significance will be examined in Section 3.4 when building the traffic part of the opportunity map.

Roaming RA Points of Interest

- Technology
  - Separating the visitor CDRs from local ones in the central billing system
- Processes
  - No identified points of interest
- People
  - No identified points of interest

3.4 The Opportunity Map

3.4.1 Overview of the Contents

The example of an opportunity map from Mattison in Section 1.5.2 is from a system, where traffic can be measured in Erlangs and revenue mapping is possible without complex averaging schemes. While this holds true for the 2G voice part of the systems in this scenario, the situation gets much more complex with the addition of the 3G and mobile content revenue management chains. In order to have comparable data between different kinds of services, we need to look at the actual data record traffic flows and make conclusions based on that.

Typically CDRs are generated when a service is used, even if the service is free[3]. In 2G networks CDRs are generated by the MSC when the call is terminated (including call attempts). With multimedia calls or long calls in general in a 3G network, one call may generate several CDRs[4] [Kor03]. These partial CDRs must be combined before they can be billed and it further complicates any mapping of CDR traffic to call duration and revenue. The voice and messaging revenue chain also includes traffic from mobile data usage.

WAP on the other hand generates EDRs for each event when browsing, such as opening a new link. As we will see later, a lot of WAP traffic is comprised of non-billable data records. Also the rating of both WAP EDRs and premium priced SMS and MMS messages happens before the central billing system, unlike with regular voice and SMS.

In order to understand the overall functionality of the billing network and to compare the mobile content revenue management chain to the voice and messaging revenue chain, three filtered maps are generated:

1. Data record traffic between systems
2. Billable data records / Total data records
3. Rated data records

3.4.2 Data Record Traffic

The traffic between the systems involved is presented in Figure 3.8. The differences between the two branches are evident. On the top the mobile content traffic flow starts with a moderate amount of data record traffic from the source platforms, but only a small portion of these records end up in the central billing system.

Below the voice and messaging traffic flow looks more like one might expect. Traffic from the network elements is combined through mediation. The 3G mediator filters out roughly half of the data records from the packet network. The prerater also filters roughly half of the traffic from the MSC. Still the data record flow into the central billing system is over 100 times higher than the flow from the mobile content side.

The amount of roaming data records in the data record flow from the prerater to the central billing system is less than a percent, so it does not burden the system in any significant way.

[3] CDRs can be used for other purposes than charging

[4] The call duration may have a breakpoint, or CDRs may be generated for each component of the call)

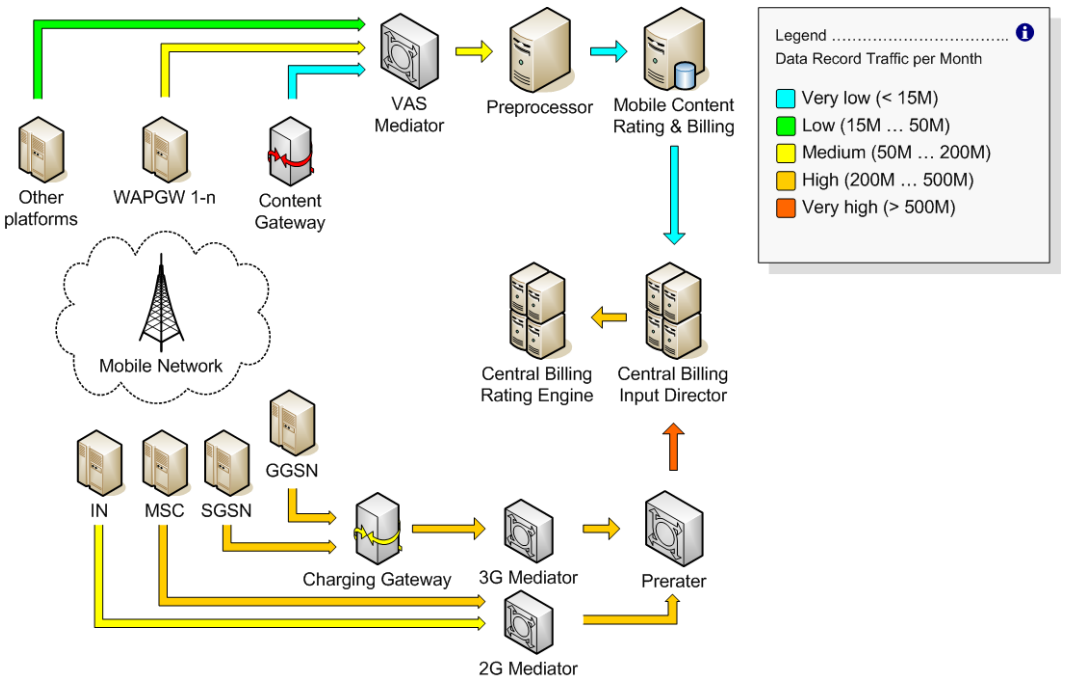

Figure 3.8: Data record traffic flows per month.

If the analysis were to be made on traffic only, the risk areas would be quite different from each other in these two revenue management chains. To get a better picture of the content of the traffic, the ratio of billable data records to the total traffic amount will be examined next.

3.4.3 Billable data records

The ratio of billable tickets to the total amount of ticket traffic is shown in Figure 3.9. In the mobile content chain there are great differences between the ratios from different platforms. While there was not a huge flow of traffic from the CGW, a relatively high percentage of the data records from that platform are billable. WAPGWs on the other hand send a lot of unbillable data records due to the nature of WAP browsing. Considering the total traffic amount, the system which filters all unwanted traffic from reaching the central billing system seems to be one of the key areas. In this case it would be the prerocessor before the mobile content rating and billing system.

In the voice and messaging revenue chain the distribution and ratio of billable tickets each platform generates is more even. This is quite expected considering the traffic flows and the nature of services in this revenue chain. The prerater does the job of filtering a lot of unwanted data, but some unbillable data records are still transferred to the central billing system for other purposes. The effect of the 3G mediator's filtering can also be seen in the billable data record ratios.

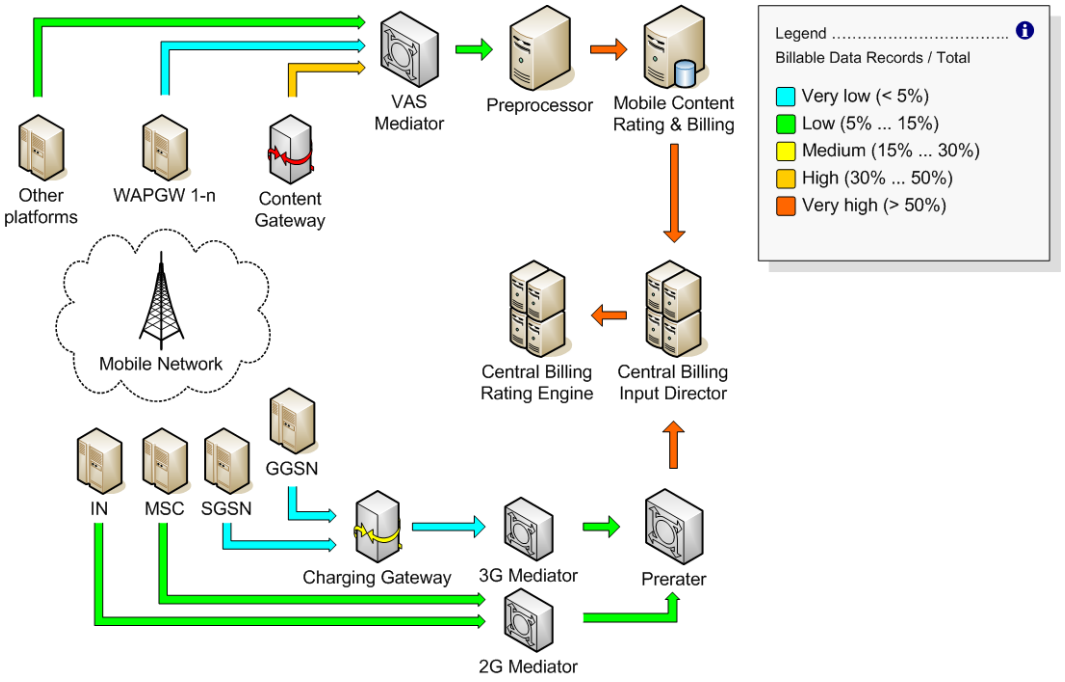

Figure 3.9: The ratio of billable data records to the total data record flows.

3.4.4 Rated data records

Rating is identified as one of the main sources of revenue leakage [Mat05]. While the central billing system rates voice and messages, there are many other services which are rated elsewhere. Figure 3.10 shows where the data records are rated on the mobile content side.

Since all platforms send unbillable data records in addition to billable data records, the rated tickets in the map are obviously also billable. The CGW forwards all the prerated[5] premium priced messages and they are only carried through the mobile content rating and billing system[6]. WAP data records are rated at the mobile content rating and billing system and then passed on to central billing. While the central billing system receives only prerated data records from the mobile content chain, it may still rerate some data records from other platforms (like the MMSC) before they are billed. The decentralized rating of mobile content adds another dimension to the prioritization problem.

Mobile voice and messaging on the other hand are rated at the central billing system as stated before. This puts another kind of load on the central rating system with the huge amount of CDR data.

[5] At the service provider's end

[6] The preprocessor splits the service provider part from the prerated data records for revenue sharing.

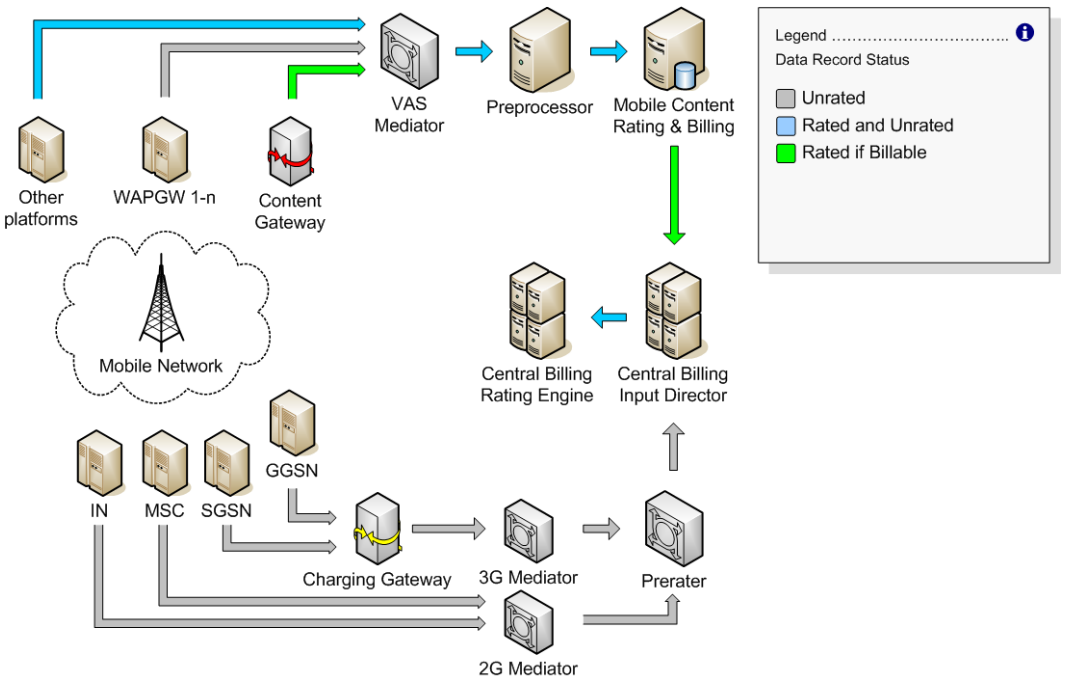

Figure 3.10: The rating of data records in the revenue chains.

The two revenue chains differ in rating practices a lot and the expert interviews should give more insight into the priorization of the revenue assurance risk areas in both of the revenue chains.

3.5 Summary

3.5.1 Scope

The mobile content chain deals with two interface products, that are aimed for service providers. These two products allow for transactions with either premium priced messages (CGW) or WAP (WAPGWs). The voice and messaging revenue chain consists of regular traffic from both 2G and 3G networks. Roaming is excluded from the scope of the analysis in order to ensure comparable results and its indirect effects on data record flows are insignificant.

The three filtered opportunity maps show two different revenue chains: mobile content, which is the main focus of the study and voice and messaging, which is used for comparison purposes.

3.5.2 Identified High Priority Systems

Rating of data records was identified as an important part of the revenue management chain. As it is decentralized on the mobile content side, it may be one of the key issues in defining the prioritization of risk areas in the chain.

Systems, that handle a lot of data record data and drop a part of the traffic based on rulesets, are also likely to be high on the priority list. These kinds of tasks fall to the preprocessor on the mobile content side and the prerater on the voice and messaging side.

Chapter 4

Prioritizing Risk Areas

4.1 Basis for Prioritization

4.1.1 Root Causes of Revenue Leakage

Revenue assurance activities should be targeted to prevent the greatest risks of revenue leakage from happening, but in order to understand why such leaks exist and where they can be found it is useful to take a look at the most common root causes of revenue leakage. Figure 4.1 shows root causes of revenue leakage from a survey

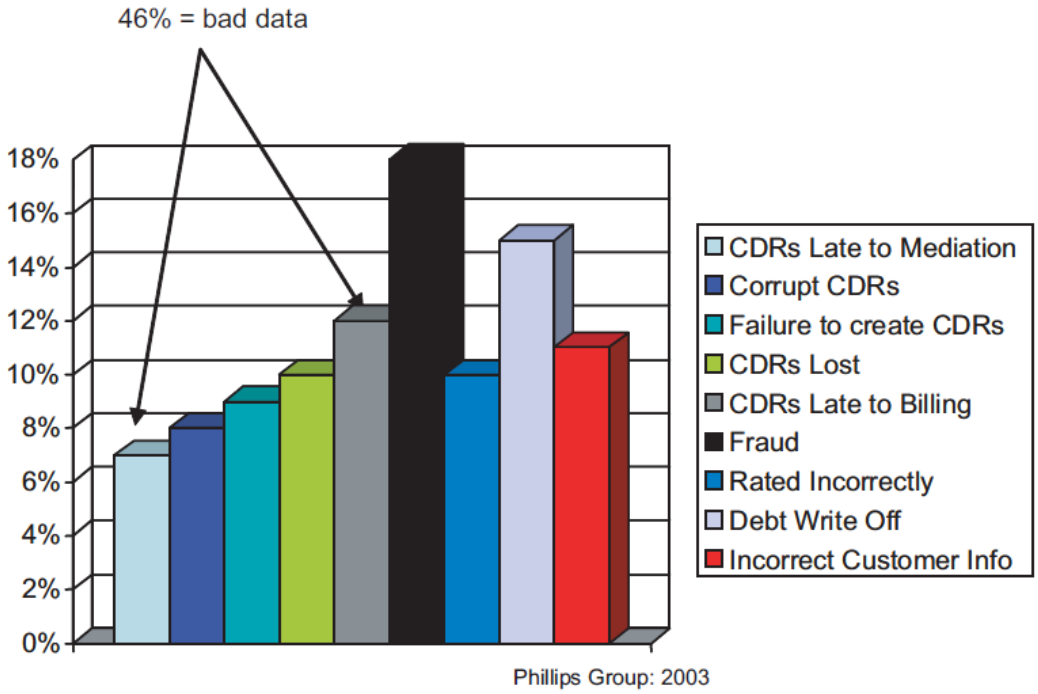

Figure 4.1: Revenue leakage root causes by Philips Group (2003).

by the Philips Group in 2003 [Mat05].

Mattison mentions, however, that survey results indicate ratios vary for different kinds of carriers in diverse situations. The results are not likely to be directly comparable to any figures from TSF, but they can give some insight into which kinds of systems are most likely to be of high risk.

While the results of the survey may only account for mobile voice, the same types of revenue leakage are possible on mobile content billing as well. By classifying the results by the types of systems responsible for the leakage and looking at how they relate to the system configuration at TSF, we can get an estimate of which systems might be of high priority.

Table 4.1: Possible operator systems at TSF related to surveyed causes of revenue leakage.

Cause of Leakage	Related Systems		Weight
	Voice and SMS	Mobile Content	
CDRs late to mediation	Mobile network	Mobile network	7%
Corrupt CDRs	MSC, SGSN, GGSN	CGW, WAPGWs, other platforms	8%
Failure to create CDRs	MSC, SGSN, GGSN	CGW, WAPGWs, other platforms	9%
CDRs lost	Mobile network - Prerater	Mobile network - Preprocessor	10%
CDRs late to billing	Mobile network - Prerater	Mobile network - Mobile content rating and billing	12%
Rating incorrectly	Central billing rating engine	CGW, Mobile content rating and billing, Central billing rating engine	10%
Incorrect customer data	Central billing	Central billing	10%
Out of Scope			
Bad debt write-off	Possibly IN for prepaid related write-offs	Same as voice	15%
Fraud	Mobile network, ?	Mobile network, ?	18%

Many of the causes of leakage can happen at multiple points in the revenue chain. While the results of such mapping are indicative at best, a lot of the weight seems to accumulate on the source platforms and network elements in addition to the

separate function of rating. The reason for this may be, that the survey results are old and individual distributions between causes of leakage vary between operators. Some operators may have been struggling with network based problems, which can be avoided today with better practices. The results suggest, however, that the beginning of the revenue chain is a main source of revenue loss concerning errors with data records.

4.1.2 Opportunity Maps Combined

Mobile Content

We can see from the opportunity maps, that the WAPGWs are sending a lot of data records, but not many of them are billable. The CGW on the other hand sends a much higher ratio of billable data records, which are also already rated. Since the preprocessor determines which data records may pass on to billing, it may be getting some unnecessary traffic from the WAPGWs. As a result only a relatively small amount of data records end up in the central billing system.

There are also other platforms, which send rated data records to the central billing system through the mobile content rating and billing system. Since there are more services, billing types and places where rating can go wrong than on the voice and messaging side, rating and the location of the rating systems in the revenue chain the may be one of the issues to watch for.

Voice and Messaging

The opportunity maps of the voice and messaging revenue chain show a cascading flow of traffic from the source platforms, which ends up being over 100 times higher than the mobile content flow at the central billing system. Every system, which needs to manage the data records somehow, is under a lot more stress than on the mobile content side. Systems like this include the prerater and the 3G mediator. As we can see from the billable data record ratio, the 3G mediator removes a lot of data records that are not needed for billing. The prerater does the same for other data records, but it also sends them to other systems. The prerater is not only under heavy traffic, but it performs several important functions as well.

The rating of voice and SMS data records happens at the central billing system. The opportunity maps do not give information on what kind of stress the rating system is under other than the high amount of data record traffic.

4.1.3 Expert Opinions

In order to get more information about the different parts of the revenue chains, six experts were interviewed in more detail about the revenue leakage risk areas. For a full summary of the interviews and the names and responsibilities of the participants, see Appendix A.

Table 4.2: Identified high priority areas by experts from different parts of the revenue chains.

Interviewee	Revenue Chain	High Risk Area(s)
1	Voice and Messaging	Prerater
2	Voice and Messaging	Rating and platforms, that create data records
3	Voice and Messaging	Prerater and IN
4	Mobile Content	Preprocessor
5	Mobile Content	Network elements and platforms
6	Mobile Content	Platforms, that create data records and revenue sharing

Mobile Content

Of the interviewees from the mobile content side, no one actually considered rating of highest priority. In fact, one said that if the data record gets as far as the mobile content rating and billing system, it gets should billed correctly. The problem was seen more in the preprocessor's control list and the risk of human error when defining the filters, which are used to prevent excess traffic from reaching the billing systems and to detect malformed data records.

Two of the interviewees saw more risks closer to the mobile network. If data records are generated in the wrong way or checks on the validity of premium priced content fail, the operator may end up sharing revenue for events, which are not collectible from the subscriber resulting in bad debt.

Voice and Messaging

The prerater was identified as a high risk system by two of the interviewees for reasons similar to the preprocessor's on the mobile content side. The prerater uses control lists to limit traffic to the central billing system. Due to the massive traffic flow, mistakes in the control lists can be costly.

The prepaid balance check from IN may also be a source of bad debt, if there are

any errors in processing the requests. The relative amount of prepaid subscriptions is low, though.

One interviewee regarded rating as the highest risk area and also noted, that if the mobile network platforms do not generate the CDRs in the right way or at all, no subscriber can be billed.

4.2 Risk Area Priority

While there is obviously need for end to end integrity along the whole revenue chain (which requires the supervision of every system), primary and secondary risk areas were identified from both revenue chains. The prioritization is based on the collected data and it is shown in Table 4.3.

Table 4.3: Revenue leakage risk area prioritization

Primary Areas	
Mobile Content	Voice and Messaging
Preprocessor	Prerater
Secondary Areas	
Mobile Content	Voice and Messaging
Mobile Content Rating and Billing	Central Billing Rating Engine
Data record generating platforms, IN	

Based on the collected information, the preprocessor from the mobile content side and the prerater from voice and messaging were identified as primary risk areas for revenue leakage. Secondary risk areas include the mobile content rating and billing system and the central billing rating engine. Also, the references from the early survey results combined with the expert opinions put a lot of emphasis on different aspects of the mobile network. Specifically platforms, that generate data records and the IN were identified as probable risk areas. While outside the scope of this study, deeper investigation into the mobile network may also reveal other areas, that are a source of leakage for both revenue chains.

Since this study deals with only one operator, the functions performed by the systems give more insight into the prioritization than their placement in these particular revenue chains. The prerater and the preprocessor both perform several critical functions:

- Filtering data records based on rulesets
- Modifying data records

- Mediation or acting as a traffic hub

The secondary risk areas contain systems, which perform important functions as well:

- Generating data records
- Rating
- Revenue sharing (mobile content rating and billing)
- Prepaid balance check (IN)

If many of the listed functionalities are performed by a single system in the revenue chain, they should be high on the priority list for revenue assurance activities. Also, with high traffic amounts and a different distribution of prepaid and postpaid subscribers, the emphasis on important areas may vary. The similarities and differences between the revenue chains and the generalizability of the results will be discussed in the next chapter.

Chapter 5

Results and Analysis

5.1 Summary of the Identified Risk Areas

The revenue leakage risk areas, that were identified in Chapter 4 are summarized below in Figure 5.1. The primary risk areas are the preprocessor and the prerater. The secondary risk areas contain systems, which perform functions such as rating and data record generation. In the light of the survey results by the Philips Group [Mat05] and the expert interviews, the whole mobile network including the source platforms in this system chart require further study.

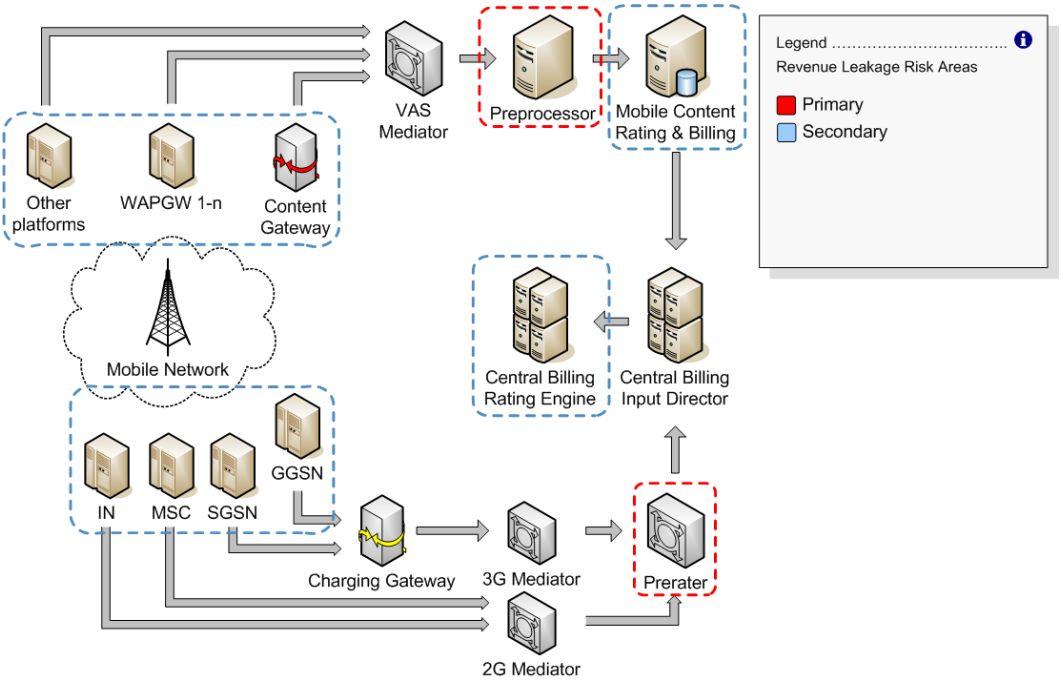

Figure 5.1: Revenue leakage risk area priority.

The results of the prioritization are directly applicable only to TSF's revenue chains. In order to assess which aspects of the results are generalizable and to what end, the similarities and differences of the revenue chains are examined next.

5.2 Comparisons

Comparisons between the two revenue chains are presented in Table 5.1. The comparisons are made across four dimensions and their impact on the interpretation and generalizability of the work are discussed below.

The rating of services differs by many factors between the revenue chains. The most obvious difference is where the data records are rated. The voice and messaging revenue chain uses a centralized rating scheme, while mobile content is rated at several different places. There is another difference concerning campaigns and discounts - voice and messaging can be rerated at the rating engine by the operator, but any discounts for mobile content will need to come from the service provider's end.

There is an inherent problem sharing revenue for events, which cannot be billed, if there are errors in any part of rating and billing the service. The CGW acts as an intermediary when receiving rated data records from service providers and only checks the price range of the event for validity. This is a somewhat unique configuration for TSF, since the same action can be performed by SMSCs according to one of the experts interviewed. Still, the rating practices of mobile content must be somewhat similar for other operators as well, because the service provider must be able to control the price of their services.

Save for the revenue sharing part in mobile content, the actual billing of subscibers is similar in both revenue chains. With postpaid subscriptions the billing is done by the central billing system. The balance checks for prepaid subscriptions in the IN differ in nature, though, and they may be significant for other operators with a higher ratio of prepaid subscriptions.

The most notable difference in the traffic flows in the revenue chains is the amount of data records, that end up in the central billing system. While there is a single interface to central billing from both chains, the traffic buildup from the source platforms is different in nature. In the mobile content side this is mostly due to WAPGWs sending excess traffic to the preprocessor, which may distort the nature of the traffic buildup. There may also be differences with the platforms used in other operators' mobile content revenue chains depending on rating practices and the services offered, which will affect traffic as well.

The data records in the revenue chains are used for the same purposes of rating, billing and network management. There are differences in the structure and the

Table 5.1: Comparisons between the mobile content and voice revenue chains by functions performed

Function	Similarities	Differences
Rating	The rating is based on data records from source platforms	Decentralized rating for mobile content Campaigns and discounts are managed the operator's end for voice and messaging and at the service provider's end for mobile content Rated events
Billing	Services from both revenue chains are billed at the central billing system	Prepaid balance checks from the IN differ in nature and may result in bad debts in several ways Revenue sharing in mobile content
Traffic	There is a single interface, through which the revenue chains interact with central billing	The traffic buildup from platforms to billing differs a lot Traffic amounts
Data record management	Both revenue chains contain systems, which filter traffic based on rulesets	Single system in charge of which data records are passed on to billing on the mobile content side, while the 3G mediator filters a part of the traffic in addition to the prerater on the voice and messaging side Data records are created in different platforms The structure of data records

platforms, which create the data records. Also the filtering practices for the revenue chains vary, because the content is different. While the contents of even regular voice CDRs may look completely different between operators [Kor03], there are bound to be differences between the generation and filtering of the data records as well.

5.3 Generalizability

Due to the explorative nature of the study and by targeting only one operator, the results can be better analyzed by breaking them into components.

Considering the systems in the TSF revenue chains, other operators have similar platforms in the mobile network end. The survey results place heavy emphasis on mobile network generated causes if leakage and experts at TSF agree, that especially data record generating platforms and the IN are risky areas on the mobile content side as well. Operators, that have a lot prepaid subscribers, may find the IN even more important. Concentrating revenue assurance efforts on the mobile network end of the revenue chain will likely help all operators.

The traffic flows and systems between the data record creating platforms and billing may be a lot different in other operators' revenue chains. Especially the mobile content revenue chain may differ a lot. No conclusions can be made on whether having a separate rating and billing system for mobile content is a common practice between operators. There is, however, one feature in the mobile content revenue chain, which must be rather common. The premium priced messages come prerated from the service provider, which means that at least part of the traffic from mobile content platforms is likely to be rated before entering the rating and billing systems of the operator.

Even though rating was not seen as the most important function in the mobile content side when considering revenue leakage, it is still one of the biggest risk areas if something goes wrong. If the mobile content market were to expand rapidly, rating might become the top revenue assurance issue especially since new billing models may be on the horizon. Other operators may have a different emphasis on the priority of risk areas and may consider rating a primary risk area on the mobile content side as well.

The systems picked for primary risk areas of revenue leakage at TSF are specific to these two revenue chains. They are similar in the sense, that they are the main filters of data record traffic in the revenue chains. They also perform other functions, like splitting the service provider's share of the revenue and adding taxes (preprocessor) or managing data records for reporting (prerater).

For other operators, an estimate of the priority for systems can be made based on the functions they perform. Any single system performing one or several of the following functions in the mobile content revenue chain is likely to be of high priority:

- Generating data records
- Modifying data records

- Filtering data records based on rulesets
- Rating

5.4 Shaping Hypotheses

At the outset of the study the plan was to see whether the high priority revenue assurance target areas of the mobile content revenue chain would be similar in any way to the voice and messaging revenue chain. With mobile content being a relatively new business compared to mobile calls and messaging, similarities with the more mature voice and messaging revenue chain would help in directing revenue assurance activities.

On a higher level the two revenue chains were found to have a similar prioritization for systems and the actions they perform. If we go into a bit more detail on the systems, functions and the content of the data records, the two revenue chains do not seem to converge on enough issues to warrant a completely similar revenue assurance approach. More study is needed especially on data record creating platforms and other mobile network elements, which were not studied in detail due to the scope of the work.

Research on other operators with different ratios of prepaid and postpaid subscribers would also be required for a decisive assessment of the generalizability of the results and to classify the revenue leakage risk areas in more detail.

A hypothesis made on the basis of this study is presented below:

> Mobile operators should primarily concentrate on systems, which filter and modify data records in the mobile content revenue chain when directing revenue assurance activities. The secondary systems are rating systems, data record generating platforms and the IN for operators with a high prepaid subscriber base.

The evidence, which supports the construct, is listed below:

- In TSF's mobile content revenue chain there is a single system, which is in charge of filtering and modifying data records for the purposes of revenue sharing. The opportunity maps show a relatively high amount of traffic being sent to the preprocessor, which must filter all the faulty and unbillable data records from the traffic flow. An expert from the mobile content billing systems confirmed, that the rulesets for detecting and filtering data records are a greater risk of revenue leakage than the rating itself.

- The rating of mobile content already happens at the service provider's end, which decentralizes rating from the mobile operator's systems. While it was not seen as the most important factor in the revenue chain, the situation may be different in other operators' environments and in the future, should the mobile content market experience rapid growth. Also new billing models will add to the possibilities of revenue leakage.

- The data record flows are different in nature based on which platform generates the data records. While the study doesn't go deep into the functionality of the mobile network, there is enough evidence from the expert interviews and the revenue leakage survey results to regard the data record generating platforms (and the IN for prepaid heavy operators) as valid targets for revenue assurance activities and further study.

Comparisons to literature are challenging with currently very few books and studies available on revenue assurance in the context of mobile content. More detailed research into mobile content revenue assurance is needed to confirm or disprove the hypothesis.

Chapter 6

Conclusions

6.1 Validity and Criteria of Success

The three validity checks for exploratory empirical research designs according to Yin [Yin94] are discussed below.

6.1.1 Construct Validity

Construct validity requires establishing correct operational measures for the concepts being studied. According to Yin, the result can be achieved by using multiple sources of evidence.

As Section 5.4 shows, several sources of evidence were used in defining the revenue leakage risk area priority. Filtered opportunity maps, survey results and expert interviews were used to reach the conclusions.

6.1.2 External Validity

External validity requires establishing the domain to which a study's findings can be generalized. While the initial restrictions of assessing the mobile content revenue chain of only one operator are still valid, some measures of generalizability were achieved in Section 5.3 by breaking down the identified risk areas by the functions that are performed.

6.1.3 Reliability

The reliability of the research design requires demonstrating that the operations of a study, such as the data collection procedures, can be repeated with the same results.

Two methods for increasing the reliability of the study are defining a case study protocol and maintaining a chain of evidence.

The case study protocol is included as Appendix A. While it is limited in scope, it has helped answer the questions concerning the collection and analysis of data. The chain of evidence can be seen in the structure of the study from working to understand the logic of the systems involved to making comparisons and approaching at the intended result.

6.1.4 Criteria of Success

Two criteria of success were defined in the beginning of the work:

- Main research question answered based on a chain of evidence from the initial research phase to the analysis of results
- Multiple sources of evidence used in defining the risk area priority

The results and the validity checks show, that both criteria are reached.

6.2 Answers to Research Questions

The answers to the relevant research questions[1] are presented below.

- How does the revenue chain of mobile content compare to voice and messaging?
  - The opportunity maps created in Chapter 3 show a visual presentation of the different aspects of the two revenue chains. The similarities and differences are further analysed in Section 5.2. Similarities in revenue leakage risk areas can be found on a high level of analysis, but on a more detailed level the revenue chains are likely to require different approaches.
- What are the revenue leakage risk areas of the mobile content revenue chain at TSF?
  - The revenue leakage risk areas were defined based on all available data in Chapter 4. In the mobile content revenue chain the primary risk area was identified to be the preprocessor, while the secondaty risk areas contain systems such as rating and data record generation.
- What conclusions and suggestions can be made on the revenue assurance approach to mobile content?

[1] See Section 1.3 for the full list

– The conclusions and suggestions are presented next and conclude the study.

The answer to the main research question is found in Section 5.4 where the hypothesis is generated and is presented below:

> How should a mobile operator prioritize their revenue assurance activities related to mobile content?

Answer:
Mobile operators should primarily concentrate on systems, which filter and modify data records in the mobile content revenue chain when directing revenue assurance activities. The secondary systems are rating systems, data record generating platforms and the IN for operators with a high prepaid subscriber base.

6.3 Suggestions

This study targeted the mobile content revenue chain on a high level in order to understand how the services work and get billed. The prioritization of the mobile content revenue chain is comparable to the voice and messaging revenue chain in TSF's systems, since there are similar systems and funtions performed in both chains. The comparisons showed many differences too, which will affect the revenue assurance approach for the revenue chains.

The hypothesis in Section 5.4 is offered as a course of action for the mobile operator for directing the revenue assurance efforts of mobile content. As a part of securing the more valuable voice and messaging revenue chain, mobile content should be taken into account as its own separate entity. While it is not a big business compared to voice at the moment, there are enough differences with the mobile content environment to warrant serious attention, if the market starts expanding at a faster rate in the future.

6.4 Recommendations for Further Study

The mobile network and data record generating platforms were identified as sources of revenue leakage, which require further study in the context of mobile content. The prioritization of revenue leakage risk areas is also dependent on the ratio of prepaid and postpaid subscribers of the operator. A study, which includes more operators with variable ratios of prepaid and postpaid subscribers, is needed to get a comprehensive assessment of the revenue assurance approach to mobile content.

Beyond the initial look at revenue assurance activities for the mobile content revenue chain there are many steps, which can provide further information. As the revenue leakage areas are identified and secured, the mobile operator should start looking into proactive approaches for preventing leakage. These approaches should be the focus of further study.

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Appendix A

Case Study Protocol

A.1 Questions about the Work

Table A.1: Case questions, sources of data and sample strategies.

Case Questions	Sources of Data	Sample Strategies
How should the existence of errors in mobile content billing be proven?	Customer service reclamations and feedback	Search through the comment fields of customer service cases for phrases related to incorrect mobile content billing
How should the data for the opportunity map be gathered?	Documentation and reports People from different parts of the revenue management chains	Reports of data record traffic between systems and the ratio of billable tickets to the total Open-ended interviews about the functionality and structure of the billing network
What should be compared between Voice & SMS and Mobile Content revenue chains?	Opportunity map, expert interviews	Revenue leakage risk areas, similarities and differences

A.2 Questions for Specific Interviewees

A.2.1 Prerequisites

When planning for an interview, there are four things that should be considered [HH91]. The answers concerning the expert interviews for this study are given below each item.

1. The relationship between the interviewer and the interviewee
    - The role of the interviewer
        - Researcher
    - The role of the interviewee
        - Expert
2. The problem statement
    - Description of the problem
        - What is the highest revenue leakage risk in the revenue chain and in which part of the revenue chain is it?
    - Information available before the interview
        - Opportunity maps, case study database
3. Intended result
    - Analysis and conclusions, that will be made based on the collected material
        - To be able to confirm the similarities and differences between the two revenue chains in terms of revenue leakage risk area prioritization
4. Required contribution
    - The material, that the interviewer should collect in order to reach the intended result
        - The experts' opinions on the highest revenue leakage risk areas and the reasons why they consider the area of high risk

A.2.2 The Interviews

To support the information in the opportunity map, an opinion of the most risky area in terms of lost revenue is asked from experts at different parts of the revenue management chains. The interview questions are intended to provide another

source of data for making the prioritization of revenue assurance risk areas and for comparisons between voice and mobile content.

The questions for the experts in different parts of the revenue management chain are listed below. The experts were allowed to answer freely and the results of the interviews are summarized after the questions.

1. In which part of the (*) revenue management chain is the risk of revenue loss the greatest?
   - (*) Mobile content or voice and messaging depending on the interviewee
2. Why is this area of high priority?

Table A.2: Interviewees for identifying high priority risk areas.

Interviewee and Revenue Chain	Title	Responsibilities
1: Luukkanen, Ari (Voice and messaging)	System Specialist	Central billing system, data record synchronization reporting
2: Jaakola, Juho (Voice and messaging)	Senior System Specialist	Charging, mediation, mobile prerater
3: Patrikainen, Eija (Voice and messaging)	Process Manager	Mobile voice billing processes
4: Juutila, Helena (Mobile Content)	Senior Project Manager	Mobile content preprocessor, mobile content rating and billing
5: Kangasharju, Ari (Mobile Content)	Systems Manager	CGW
6: Eronen, Pasi (Mobile Content)	Development Manager	Service provision solution, WAP and Messaging Interface products

Table A.3: Summarized results of the expert interviews.

Interviewee	Risk Areas	Reasons
1	Prerater	The prerater drops data records based on rulesets and if billable records are erroneuosly dropped the impact can be high.
2	Rating and platforms, that create data records	If the data record is not created for some reason and it is not detected, then no revenue can be collected for the event. Also for data record errors before the central billing system, the process for restoring the data must be in order (including detecting errors, reloading the data records, removing the erroneus data, reporting etc.).
3	Prerater and IN	The prerater removes double data records, which are sometimes generated in the network. However, some data records (like long multiple part SMS messages) can be misinterpreted as doubles. It is possible, that other such problems exist in the prerater, which are not known yet. The prepaid balance check from IN may also be a source of bad debt, if there are any errors in processing the requests.
4	Preprocessor	If the data record gets to the mobile content rating and billing system, it is usually rated correctly. Also the platform (CGW, WAPGW, others) - VASMD connections are rather reliable. If the preprocessor drops data records based on wrong rules due to human error, for example, there can be revenue leakage. The root cause of the error may also be difficult to find out with mobile content.
5	Network elements and platforms	If the service numbers are not directed correctly in the network, the operator may end up sharing revenue which is not collectible from the subscriber. Also updates to data record structure pose a high risk in the whole revenue chain.
6	Platforms, that create data records and revenue sharing	Since the same data is used for billing and revenue sharing, detecting errors from the network may be difficult. There is a risk of bad debt, if revenue is shared from events that are not from Sonera's subscribers.

Appendix B

Interviewees

B.1 Full List of Interviewees

Eronen, Pasi Development Manager (Mobility, Mobile Content Interface Products)

Halinen, Kaarlo Senior Project Manager (Mobility)

Jaakola, Juho Senior System Specialist (Mobility, Prerater and Mediation)

Juutila, Helena Senior Project Manager (Mobility, Mobile Content)

Kangasharju, Ari Systems Manager (Mobility, CGW)

Luukkanen, Ari System Specialist (Mobility)

Orhala, Hanna System Specialist (Mobility)

Patrikainen, Eija Process Manager, Revenue Accounting (Finance)

Poutiainen, Petri Billing Coordinator (Broadband, Mobile Content)

Salmi, Oili Department Manager (Mobility)

Vienola, Maila Department Manager (Mobility)